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ABSTRACT

Nutrition is well-recognized as a necessary component of educational programs for physicians. This is to be valued in that of all factors affecting health in the United States, none is more important than nutrition. This can be argued from various perspectives, including health promotion, disease prevention, and therapeutic management. In all cases, serious consideration of nutrition related issues in the practice is seen to be one means to achieve cost-effective medical care. These modules were developed to provide more practical knowledge for health care providers, and in particular primary care physicians. This module is designed as a resource which will assist the primary care physician in understanding the functions of vitamins and trace minerals. Manifestations of deficiency and excess are presented as are concepts relevant to the evaluation of patient status. Information is provided to assist physicians in counseling their patients regarding the multitude of claims made concerning dietary supplements. Included are learning goals and objectives. A self-check of achievement with regard to goals references, and lists of resources for patients and physicians. Appendices include tables of recommended dietary allowances, safe and adequate dietary intake of selected vitamins and minerals, clinical nutrition examination findings, laboratory test interpretations, plasma and urine nutrient levels, healthy foods, and a food composition table for dietary analysis. (CW)

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2. Appraisal of Nutritional Status
3. Nutrient and Drug Interactions
4. Normal Diet: Age of Dependency
5. Normal Diet: Age of Parental Control
6. Normal Diet: Adolescence
7. Normal Diet: Pregnancy and Lactation
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9. Dietary Management in Obesity
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23. **Vitamins and Trace Minerals**
24. **Behavioral and Neurological Disorders**
25. **Preventing Hospital and Home Malnutrition**
26. **Questions About Common Ailments**

Faculty Guide (includes comprehensive index for Modules 1-26)

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Introduction

Billions of dollars are spent annually on questionable nutrition remedies that include vitamins and trace minerals. This money could be used to a better advantage by buying a variety of foods that would supply the vitamins and minerals and other nutrients for human nutrition.[1] Proper storing, preparing, and cooking of meats, fruits, and vegetables will provide adequate nutrients giving more for the money. The media often promote questionable practices that have not adequately answered the basic questions, "Is it more effective than a placebo?" and "Is it safe?"[2] Patients should be warned that following the advice of health food faddists can often result in serious illness.

Why do so many people take extra supplements that they do not really need? Common reasons given are to provide nutritional insurance, to increase strength and energy or vitality, to improve health, to compensate for stress, to prevent disease, and to treat illness. In the words of Herbert and Barrett[3]:

> Some people would argue that the apparent benefits of 'believing' in food supplements outweigh the risks involved. Do you think that people need false beliefs in order to feel healthy or to succeed in life? Would you like to believe that something can help you when in fact it is worthless and may be harmful? Do you want our society to support an industry that is trying to mislead us? Can't Americans do something better with the billions of dollars being wasted each year on food supplements?

Goal

The goal of this module is to provide a resource which will assist the primary care physician in understanding the functions of vitamins and trace minerals. Additionally, manifestations of deficiency and excess are presented, as are concepts relevant to the evaluation of patient vitamin and trace mineral status. The information provided is intended to assist the physician in counseling patients regarding the multitude of claims currently being made concerning vitamins and trace minerals.

Objectives

Upon completion of this module, you will be able to:

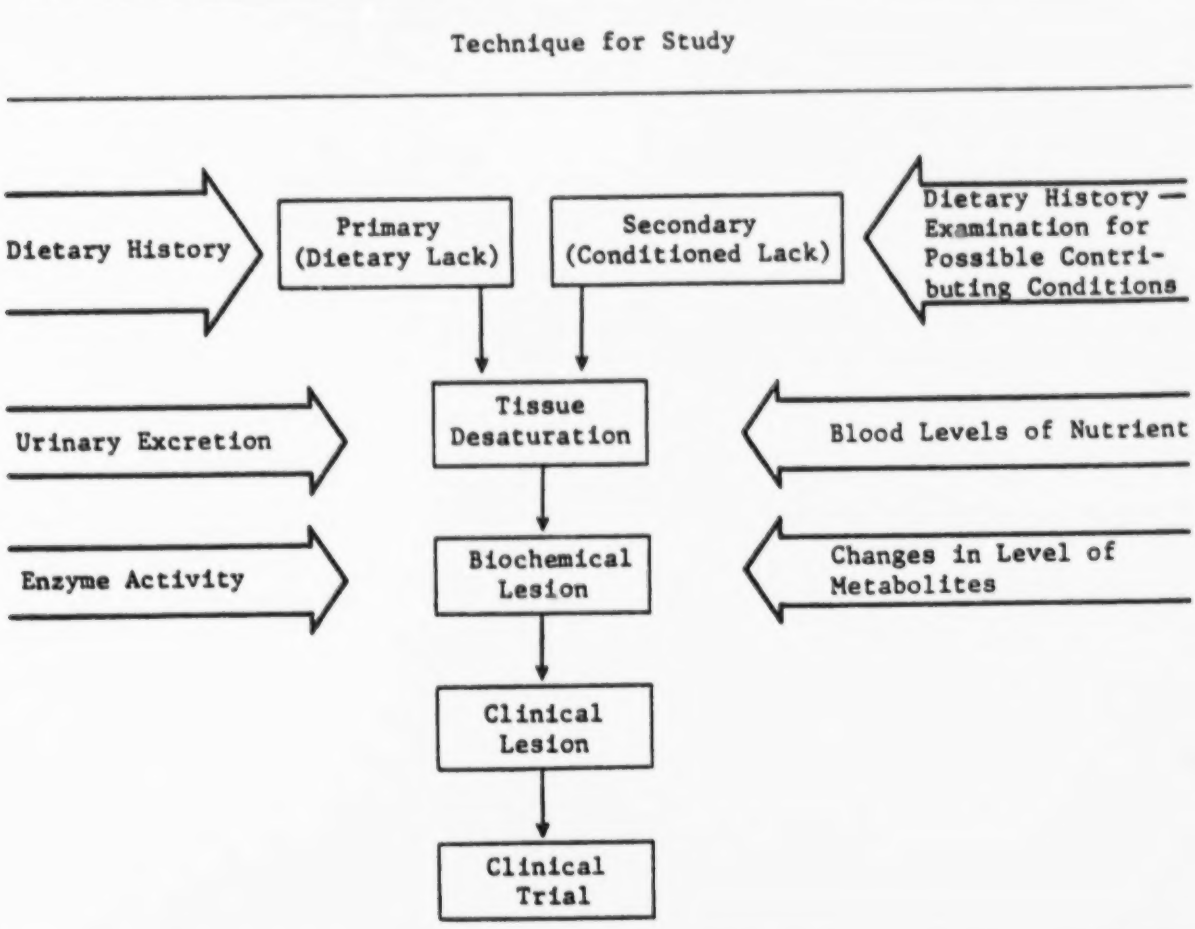
1. *Demonstrate currency in knowledge regarding vitamins and trace minerals.*
2. *Identify basic vitamin and trace mineral needs for a variety of patients.*
3. *Specify dangers of megavitamin therapies for fat- and water-soluble vitamins and for trace minerals.*
4. *Refute erroneous or unproven claims about trace minerals and vitamins.*
5. *Counsel patients regarding basic vitamin/trace mineral needs for their medical care and recommend supplementation if necessary.*

Vitamins

Vitamins are organic substances which are essential for normal metabolism, growth, and development. They are effective in small amounts and function primarily as regulators of metabolic processes and energy transformations, usually as co-enzymes.

Vitamins are organic substances which are required by the body in small amounts for metabolic functions. They cannot be made in the body and must be obtained through the diet. After absorption from the food ingested, vitamins are carried in the blood to cells whose functions depend on them. After entering the cell, vitamins combine with enzymes, called apoenzymes, resulting in a holoenzyme that catalyzes reactions inside the cell. The quantity of apoenzymes is limited. The apoenzymes are usually saturated and, therefore, are at

Figure 23-1 Sequence of Events Leading to Clinical Nutrition Lesion



From Pearson, W.N.: "Biochemical Appraisal of the Vitamin Nutritional Status in Man." *Journal of the American Medical Association*, 180:49-55, 1962. Used with permission of the American Medical Association.

maximum activity in the amounts of vitamins suggested in the Recommended Dietary Allowances (RDAs).

As a primary care physician, if you find a picky eater in a family and/or the family has poor eating habits and food intake, a daily vitamin and mineral capsule containing the RDAs for adults and children (Appendices A and B) may be useful in meeting nutrition needs. But until science proves the case for megavitamins, except for some medical conditions, taking larger doses for real or fancied ills not only wastes money but may endanger health. Many articles in popular magazines, newspapers, books, and other publications encourage use of vitamins, but only a few discuss the possible toxicity which can result from their excessive use. Generally a megadose is considered to be about ten times the RDA. It is important to understand the difference between treatment or prevention of a specific deficiency disease and the use of vitamins as pharmacologic agents. The efficacious treatment of disorders with megavitamins will be discussed later in this module.

Fat-soluble vitamins A, D, E, and K are all soluble in lipids, and have varying functions in the body. Research has provided extensive information concerning the actions of vitamins D and K, but limited evidence is available concerning the actions of vitamins A and E. In general, it is difficult to develop deficiencies of fat-soluble vitamins resulting from dietary intake unless the individual has developed a malabsorption syndrome. Since fat-soluble vitamins are stored in the liver, toxicity can be induced by megadoses, especially of vitamins A and D.

Water-soluble vitamins include the members of the B-complex family and ascorbic acid (vitamin C). These vitamins are stored in the body but not in as large quantities as fat-soluble vitamins. It was once believed that these vitamins must be consumed daily or deficiency would occur, but now we know that this is not true.

Marginal or mild cases of vitamin deficiencies often occur in growing children, adolescents, and the elderly. These groups may not be well fed because of insufficient income, lack of knowledge, poor dietary habits, or disease.

Figure 23-1 diagrams the sequence of events leading to clinical nutrition deficiency.

The symptoms that develop at the various stages of vitamin deficiency are presented in Table 23-1.

Excessive amounts of vitamins, which serve no nutritional purpose, have pharmacologic and/or toxic effects. If one eats daily a variety of fruits, vegetables, meats, milk and milk products, eggs, and whole grain products in quantities suggested in the Guide to Good Eating (Appendix F), vitamin supplementation is not necessary

Table 23-1 Development of Vitamin Deficiency

Sequence	Deficiency State	Demonstrable Symptoms & Comments
1	Preliminary	Inadequate availability of vitamin due to diet, malabsorption, and abnormal metabolism
2	Biochemical	Enzyme-coenzyme activity depressed; urinary vitamin reduced to negligible levels
3	Physiological	Loss of body weight concurrent with appetite loss, general malaise, insomnia, and increased irritability
4	Clinical	Increased malaise, loss of body weight with the appearance of deficiency syndrome
5	Anatomical	Establishment of specific deficiency disease with specific tissue pathology; unless reversed by repletion, death results.

From Brin, M. and Roe, D.: "Drug-Diet Interactions." In *Nutrition and Medical Practice*, L.A. Barness (ed). Westport, Connecticut: AVI Publishing Co., 1981, p. 157. Used with permission of the publisher.

and toxicities will not occur. These guidelines may be given to patients and will enable them to check the number of servings of various foods each day for different age groups. The recommended food intake for good nutrition, according to food groups, and the average size of servings at different age levels for children from 1 year to 15 years are presented in Appendix A; this is an excellent patient handout.

Trace Minerals

Trace minerals are essential in very small amounts in the diet because they are not synthesized by the body. Trace minerals are parts of many enzymes necessary for metabolic activity. As the American diet changes to include more and more highly refined, processed, and fabricated foods containing fewer micronutrients, there is increased concern that deficiencies may result. This concern is not valid, however, if a variety of foods is consumed and calorie and protein needs are met.

The gastrointestinal tract is the site of absorption of trace minerals and important interactions between minerals. For example, medications with iron may depress the absorption of copper. Copper in turn may lower iron and molybdenum absorption. For transport via blood, minerals are usually bound to a protein. In general, foods of animal origin are superior to grain, vegetables, or fruits as sources of trace minerals since concentrations tend to be higher and the minerals are often more bio-available. Manganese is an exception; it is readily available from plant sources.

Trace elements are not evenly distributed in foods such as grains. Milling technology removes the germ and outer layers which contain the most minerals. When foods such as grain are highly processed, trace minerals are lost. Most bread and cereal products today are fortified with bioavailable B-vitamins and iron, and sometimes with trace minerals. Loss of trace minerals with processing is not a major nutrition concern because a well-balanced, varied diet which includes foods from the basic food groups will supply adequate trace minerals. Only small amounts of trace minerals are needed by the body; therefore the term "trace" elements.

Use of This Module

In order to assess the adequacy of a patient's diet, you might ask your office nurse or secretary to assist a patient in answering the questions in Table 23-2. If answers to these questions alert you to a potential nutrition problem, a more thorough nutrition history and evaluation of the dietary intake may be needed. Use the Food Composition Table for Short Method of Dietary Analysis (Appendix G) to evaluate dietary intake.

The following outlines for vitamins and trace minerals contain information concerning (1) function, (2) nutritional assessment guidelines, (3) Recommended Dietary Allowances for all ages, (4) laboratory tests, (5) major causes and clinical manifestations of deficiencies with long-term inadequate intake or high needs, (6) major causes and clinical manifestations of excessive long-term intake, and (7) nutrient/drug interactions. For each nutrient, there are also questions that patients may ask concerning them and information that will enable you to answer their questions. Appendix C (Clinical Nutrition Examination), Appendix D [Interpretation of Laboratory Tests for the Evaluation of Nutritional Status (Adults)], and Appendix E (Plasma and Urine Nutrient Levels of Vitamins Indicative of Inadequate Intake, Malabsorption, or Increased Requirement) will also be of assistance to you in evaluating a patient for vitamin and mineral status.

The last section of this module contains information on controversial topics related to vitamins and trace elements, such as the use of hair analysis for a nutritional assessment; use of megavitamins (ortho-molecular and molecular medicine); non-vitamins pangamic acid (B_{15}), laetrile (B_{17}), choline, vitamin P, and carnitine.

Fat-Soluble Vitamins

Vitamin A

Chemical Names

- Vitamin A
  - Retinol
  - Retinoic Acid
  - Retinal
  - Carotenoids

Functions

1. Combines with opsin to form rhodopsin of retina necessary for normal dim light vision.

Table 23-2 Questions Appropriate for Obtaining Information on Dietary Intake

Do you drink milk or eat products made with milk? If so, how much and how often?
Do you eat fruits or vegetables or drink fruit or vegetable juices? If so, how much and how often?
Do you eat meat, eggs, fish, poultry? If so, how much and how often?
Do you eat cereal, bread, starches? If so, how much and how often?
Do you eat pies, pastries, cakes, candy, nuts, butter or margarine? If so, how much and how often?
How do you prepare any foods which you cook? Do you cook with butter, margarine, salt, spices, oils, gravies, sugar, syrup, or other items?
Do you drink more than four ounces of liquor a day? How much beer? Wine?
Do you take vitamins, minerals, or "tonics" as supplements? If so, what do you take?
How often do you grocery shop? (If the patient is elderly, ask if grocery shopping is difficult due to lack of transportation or problems carrying heavy bags.)
Who does the grocery shopping for the family?
What cooking facilities do you have?
Who prepares meals at your home?
How many meals do you eat at home weekly?
How many meals do you eat outside the home weekly? When you eat out, how much different is your food selection from when eating at home?
Have you ever been on any previous dietary modifications, or are you presently following any special diet?
What foods do you avoid? Why?
Do you use any "health foods" or buy any special foods from health food stores? If so, what?

From Module 2, Appraisal of Nutritional Status, p. 15.

2. Maintenance of normal epithelial structure and differentiation of basal cells into mucous-secreting epithelial cells.
3. Formation of tooth enamel.
4. Growth and development of skeletal and soft tissues, protein synthesis, and bone cell differentiation.
5. Reproduction and lactation.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in vitamin A:

   Liver, Kidney, Egg, Milk, Cheese — Preformed vitamin A is found only in animal protein.

   Carrots, Sweet potato, Spinach, greens, Apricots, Cantaloupe, Broccoli — These foods provide carotene which is converted in the liver to vitamin A.

2. Daily RDAs [in μg retinol equivalent (RE)]

   Men = 1000
   Women = 800
   Pregnancy = 1000
   Lactation = 1200
   Children = 400-700
   Infants = 400-420

   One retinol equivalent (RE) = 1 μg retinol or 6 μg beta carotene or 3.33 IU.

3. Laboratory Tests

   Serum retinol-binding protein
   Plasma retinol
   Dark adaption tests
   Serum vitamin A

Major Causes of Hypovitaminosis A

1. Inadequate intake of foods providing vitamin A in the diet.
2. Excessive use of laxatives such as mineral oil.
3. Alcoholism may result in decreased food intake and prevent vitamin A mobilization from liver stores.
4. Secondary to protein-calorie malnutrition, celiac disease, sprue, obstructive jaundice, infectious hepatitis, cystic fibrosis, bile acid deficiency, ulcerative colitis, cirrhosis, alcoholism, diabetes mellitus*, hypothyroidism*
   (*interferes with conversion of carotene to vitamin A)
5. On the basis of available data, ingestion of vitamin A in amounts greater than 5 to 10 times the RDA should not be condoned without special reason and close supervision by a nutritionist or physician.

Clinical Manifestations of Hypovitaminosis A

Mild
Dry skin
Tunnel vision
Night blindness
Follicular hyperkeratosis
Changes in mucous membranes of GI, respiratory, and genitourinary tracts lead to increased susceptibility to infections.

Severe
Xerophthalmia
Atrophy
Keratinization of skin
Keratomalacia

Major Causes of Hypervitaminosis A

1. Vitamin A toxicity is seen most frequently in children and adolescents. The toxicity of the vitamin depends on age, dosage, and duration of administration. The following amounts are known to be toxic intake levels for individuals (in some cases toxicity can occur at lower levels):

   Infants less than 1 year of age: 18,000-60,000 IU daily (13 to 43 times the RDA)

   Children age 1 to 5 years: 80,000-500,000 IU daily (40 to 250 times the RDA)

   Adults: 200,000-275,000 IU daily (40 to 55 times the RDA)
2. Brain tumor (pseudotumor cerebri) develops from doses of 90,000 to 700,000 IU of vitamin A.
3. Hydrocephalus results in children given too much high-potency supplements.
4. Excess vitamin A prescriptions may cause hypercalcemia in patients undergoing hemodialysis.
5. Large doses stimulate humoral and cell-mediated immunological responses in animals.

Clinical Manifestations of Hypervitaminosis A

GI
Anorexia
Nausea and vomiting
Enlarged liver and spleen; liver damage

Integumentary
Scaly and dry skin
Alopecia
Lip fissures
Increased pigmentation
Gingivitis

CNS
Irritability
Headache
Fatigue
Lethargy
Malaise
Papilledema

Skeletal
Increased fragility and pain of long bones
Slow growth
Decalcification of bone

Other
Anemia
Nosebleeds
Hypertension
Blurred vision
Hypercalcemia
Brittle nails

Nutrient/Drug Interactions

1. Cholestyramine decreases absorption of vitamin A

because cholestyramine binds bile acids thus preventing absorption of fat-soluble vitamins.

2. Excess vitamin A reduces absorption of vitamin K leading to possible hemorrhage.
3. Mineral oil and excessive use of laxatives decrease absorption of vitamin A.

Questions and Answers

Q. Will eating carrots, carrot juice, broccoli, or spinach in excessive amounts cause my skin to turn yellow?

A. Excessive intake of carotene may give the skin an orange appearance (hyperbetacarotenemia) but does not cause the toxic effects of vitamin A. One cup of cooked carrots provides 16,000 IU of vitamin A, and including 1 cup of carrots daily would provide more than 5 times the RDA.

Q. Will vitamin A relieve acne?

A. Use of oral vitamin A for acne has not been shown to be effective in relieving acne, however, Accutane (13-cis-retinoic acid), a vitamin A analog, has been approved for treatment of severe cystic acne[1,2]

Q. Will a diet high in cod liver oil protect me from heart disease?

A. Eskimos have a diet high in fatty types of fish and also demonstrate reduced platelet aggregability, and a lower incidence of cardiovascular disease. This does not, however, prove a cause-effect relationship, and there are no data to indicate that fish oils efficaciously prevent or treat heart disease. High doses of fish oils should not be eaten because of the possibility of vitamin A toxicity.

Q. Should I take extra vitamin A if my skin and hair are dry?

A. Heredity chiefly determines skin and hair texture and oil content. Vitamins, including vitamin A and minerals, along with other nutrients, are necessary for healthy skin and hair. Nutrient deficiencies may result in poor skin and hair texture; replacement with supplementation is important if documented deficiency occurs. Vitamin/mineral supplements are not helpful in preventing or treating dry skin and hair if a varied adequate diet is ingested.

Q. Can vitamin A prevent cancer?

A. Vitamin A is essential in maintaining epithelial cell integrity, including mucous lining cells of the GI tract and lung. A deficiency could theoretically allow epithelial-type cancers to develop. Whether vitamin A or beta-carotene will prevent or treat epithelial-type cancers is unknown.

The NRC/NAS Committee on Diet, Nutrition, and Cancer recommends that people consume citrus fruits and dark green and deep yellow vegetables daily. The Committee discourages the use of supplementation of vitamin A because of its potential toxicity.[3]

Vitamin D

Chemical Names

Cholecalciferol (D_3)
Ergocalciferol (D_2)
Antirachitic Factor

Functions

1. Aids in absorption of calcium and phosphorus from the intestinal tract.
2. Plays an essential hormonal role in calcium homeostasis.
3. Necessary for calcification of bones and teeth.
4. Essential for normal growth and development.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in vitamin D:

   Fortified milk and milk products
   Fish
   Liver
   Egg yolk

2. Exposure to the ultraviolet rays of the sun.
3. Daily RDAs [in μg, where 10 μg = 400 IU)

   Men = 5-10
   Women = 5-10
   Pregnancy = 10-15
   Lactation = 10-15
   Children = 10
   Infants = 10

4. Laboratory Tests

   Total serum calcium
   Serum phosphorus
   25-hydroxycholecalciferol
   Alkaline phosphatase

Major Causes of Hypovitaminosis D

1. Inadequate dietary intake.
2. Lack of sunlight.
3. Intestinal absorption defect (sprue, steatorrhea, pancreatic insufficiency, prolonged biliary obstruction).
4. Uremia in which metabolism is abnormal.

Clinical Manifestations of Hypovitaminosis D

Osteomalacia
Osteoporosis
Rickets
Cardiac arrhythmias

Major Causes of Hypervitaminosis D

Excess intake of 2000 to 100,000 IU may cause toxic reactions through supplements or cod liver oil.

Clinical manifestations of hypervitaminosis D

Excessive calcification of bone
Kidney stones
Hypercalcemia
Headache
Weakness
Nausea and vomiting
Constipation
Polyuria
Polydipsia
Hypertension
Cardiac arrhythmias

Nutrient/Drug Interactions

Mineral oil, cholestyramine resin, and magnesium-containing antacids inhibit absorption of oral vitamin D.

Questions and Answers

Q. Should the elderly receive supplemental vitamin D?

A. Barzel[1] concludes that vitamin D deficiency is a risk in old age because of insufficient intake and lack of exercise. Many elderly are often housebound or chronically ill and are deprived of sunshine. In addition, many elderly individuals do not like to drink milk or eat foods high in vitamin D. Barzel recommends that elderly patients at risk be evaluated for osteomalacia and treated accordingly.

Q. Is vitamin D beneficial for individuals suffering from rheumatoid arthritis?

A. Excessive doses of vitamin D will not alleviate symptoms of rheumatoid arthritis and will most likely cause hypervitaminosis. On the basis of available information, it appears that 2 to 3 times the RDA for vitamin D is safe for children and adults.

Q. What is the role of vitamin D in osteoporosis?

A. Supplementation of vitamin D above the 1000 IU/day could result in toxicity, hypercalcemia, and hypercalciuria. There is no proven benefit with the use of excessive vitamin D in the treatment of osteoporosis. Adequate intake of vitamin D is necessary for proper calcium metabolism, and thus it is one factor in the prevention of osteoporosis. The RDA of 400 IU of vitamin D daily is provided by one quart of milk. (See Module 21, Protecting Bone and Teeth, for more information and discussion of calcium, phosphorus, and vitamin D relationships.)

Vitamin E

Chemical Names

Alpha-, beta-, gamma-tocopherol (80% of total activity of vitamin E is alpha-tocopherol)

Functions

1. Prevents oxidation of vitamin A and ascorbic acid.
2. Acts as intracellular anti-oxidant to prevent formation of peroxides from lipids.
3. Appears to protect integrity of cellular and intracellular structures.
4. Important for normal neurological functions.[1]
5. Plays a role in hemoglobin synthesis.
6. Requirement for vitamin E is increased with an increased dietary intake of polyunsaturated fatty acids, especially linoleic acid.[2]

Nutritional Assessment Guidelines

1. Evaluate diet for the following foods high in vitamin E:

Vegetable and seed oils
Nuts
Butter, margarine
Whole wheat grains, grain germ
Meats
Fish

Eggs
Legumes
Green vegetables
Liver
Milk, whole

Vitamin E is widely distributed in food, and therefore deficiency in man is uncommon.

2. Daily RDAs [in mg Tocopherol Equivalents (TE)]
   Men = 8-10
   Women = 8
   Pregnancy = 10
   Lactation = 11
   Children = 5-7
   Infants = 3-4
3. Laboratory Test
   Serum tocopherol levels

Major Causes of Hypovitaminosis E

1. Hemolysis and megaloblastic anemia in infants fed cow's milk.
2. May result from an impaired ability to absorb fat, as in cystic fibrosis, biliary atresia, sprue, and malabsorption syndrome.
3. Deficiency may also be found in patients with abeta-lipoproteinemia, an inability to secrete beta-lipoprotein, the primary transport protein for tocopherol.

Clinical Manifestations of Hypovitaminosis E

Edema
Skin lesions
Muscle weakness
Creatinuria
Hemolysis in patients with severe fat malabsorption
Intermittent claudication
Impaired neuromuscular function

Major Cause of Hypervitaminosis E

Excessive intake by self-medication.

Clinical Manifestations of Hypervitaminosis E

Blurred vision by antagonizing vitamin A
Delayed clotting time by interference with vitamin K
Muscle weakness
Hypoglycemia
GI pain
Dizziness
Fatigue
Nausea
Headaches

Nutrient/Drug Interactions

1. Excess vitamin E can interfere with vitamin K utilization leading to impaired blood coagulation.
2. Mineral oil and bile sequestrants decrease absorption of vitamin E.

Questions and Answers

Q. Will vitamin E prevent muscular dystrophy?

A. Animal studies first showed that vitamin E-deficient monkeys, rabbits, and chickens developed a condition similar to muscular dystrophy. However, in people factors other than vitamin E deficiency cause muscular dystrophy. Further attempts to demonstrate benefits of vitamin E supplementation have been unsuccessful.[3]

Q. Does vitamin E protect against cancer?

A. Animal studies have shown that vitamin E is not a protection against cancer, nor does a deficiency of vitamin E increase the incidence of cancer.

Q. Will vitamin E protect against effects of air pollution?

A. Studies on rats have shown that vitamin E may protect against damage to the polyunsaturated fats in lung membrane caused by high concentrations of nitrogen dioxide and ozone.[4]

Q. Will vitamin E improve an athlete's ability?

A. Most reports are anecdotal and not supported by scientific studies. Investigations with vitamin E supplements showed that performance was no better than with a placebo.[5]

Q. Will vitamin E heal burns or cuts?

A. Vitamin E liquid or ointment applied to burns or cuts is claimed to have healing properties, but no conclusive evidence is currently available. Clinical studies are underway to investigate this claim.

Q. Is there a relationship between selenium and vitamin E?

A. Vitamin E helps to maintain the functional integrity of subcellular membranes, although this is only part of the cell's defense against peroxidation of vital phospholipids. Even with adequate vitamin E, some peroxides are formed. Selenium, as a part of the enzyme glutathione peroxidase, is considered to act as the second line of defense, destroying these peroxides before they have an opportunity to cause membrane damage.[6]

Q. Does vitamin E help in easing symptoms of premenstrual syndrome (PMS)?

A. Vitamin E supplementation may be of value for women with severe PMS, but the verdict is not yet in, and studies continue. The suggested dose is often 300 mg of tocopherol per day.

Q. Does vitamin E improve sexual potency?

A. Megadoses of vitamin E do not increase sexual potency. In fact, excessive intake may reduce sex drive.

Vitamin K

Chemical Names

Vitamin K
Phylloquinone (vitamin K)
Anti-hemorrhagic factor
Menadione (synthetic)
Phytonadione (vitamin K_1)

Functions

1. Prothrombin (factor II) synthesis.
2. Synthesis of related proteins involved in blood clotting (factors VII, IX, X).
3. May participate in tissue respiration.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in vitamin K:

   Liver
   Green leafy vegetables (spinach, greens, broccoli, lettuce)
   Cabbage
   Cauliflower
   Tomatoes
   Wheat bran
   Vegetable oils
   Cheese
   Egg yolk
   Fish oils

2. Daily RDAs [not established; safe and adequate daily intakes as follows (in μg)]

   Adults = 70-140
   Pregnancy = 70-140
   Lactation = 70-140
   Children = 15-60
   Infants = 10-20

3. Laboratory Tests

   Prolonged prothrombin time occurs in vitamin K deficiency and in other bleeding disorders
   Plasma vitamin K

Major Causes of Hypovitaminosis K

1. Excessive amounts of anticoagulants.
2. Hemorrhage and blood loss.
3. Long-term parenteral nutrition with inadequate vitamin K.
4. Malabsorption syndrome — sprue, ulcerative colitis, bile fistula.
5. A newborn may be vitamin K deficient until its bacterial flora are established.
6. May occur secondary to
   obstructive jaundice;
   pellagra;
   chronic liver disease; and
   antibiotic therapy, especially broad-spectrum, long-term.
7. Deficiency from inadequate food intake is rare.

Clinical Manifestations of Hypovitaminosis K

Ecchymosis and epistaxis may occur after minimal trauma

GI bleeding

Hematuria

Prolonged prothrombin time

Newborn - bleeding circumcision

Major Cause of Hypervitaminosis K

Excessive doses of synthetic vitamin K can be toxic if given over a long period of time.

Clinical Manifestations of Hypervitaminosis K

Large doses given to premature infants may cause hemolytic anemia with red blood cell destruction

Kernicterus in the infant

Liver damage

Hypothrombinemia

Renal tubule degeneration

Nutrient/Drug Interactions

1. Neomycin reduces bacterial synthesis of vitamin K.

2. Vitamin K absorption is decreased with use of drugs such as mineral oil, cholestyramine, salicylates, anti-coagulants.
3. Sodium warfarin (Coumadin) may block conversion of vitamin K to its active form, which then prevents conversion of precursor proteins to active clotting factors.

Question and Answer

Q. Are megadoses of vitamin K needed for healthy people?

A. Vitamin K occurs abundantly in foods found in the average diet so that, with the exception of the premature newborn infant or patients with increased requirement, a varied diet should meet needs.

Water-Soluble Vitamins

Ascorbic Acid

Chemical Names

Vitamin C
Ascorbic Acid

Functions

1. Acts as antioxidant to protect essential fatty acids and other antioxidants, vitamins E and A.
2. Promotes wound healing.
3. Improves resistance to infection.
4. Essential in steroid hormone synthesis.
5. Reduces ferric to ferrous iron to aid in iron absorption.
6. Essential for integrity of cell structure, cartilage, dentine, and capillaries.
7. Essential in synthesis of collagen — conversion of proline to hydroxyproline.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in ascorbic acid:

   Citrus fruits
   Liver
   Broccoli
   Spinach
   Collard greens
   Kale
   Parsley
   Sweet green peppers
   Guava
   Cabbage
   Potatoes
   Strawberries

2. Daily RDAs (in mg)

   Men = 60
   Women = 50-60
   Pregnancy = 70-80
   Lactation = 90-100
   Children = 45
   Infants = 35

3. Laboratory Tests

   WBC ascorbic acid
   Serum or plasma ascorbic acid

Major Causes of Hypovitaminosis C

1. When prolonged dietary intake of fruits and vegetables is poor, as seen in alcoholics, poor and aged people on limited diets, severely ill people under chronic stress, and infants fed exclusively cow's milk, a nutritional deficiency can occur.
2. Smoking increases vitamin C requirement, perhaps doubling the need.

Clinical Manifestations of Hypovitaminosis C

Severe deficiency of ascorbic acid causes
Scurvy
Decreased urinary excretion of ascorbic acid
Anemia
Swollen and inflamed gums
Loose teeth
Swollen wrist and ankle joints
Multiple subcutaneous hemorrhages with pain on motion
Failure of wounds to heal
Secondary infections in the bleeding area
Rib junction enlargement

Major Cause of Hypervitaminosis C

Can result from megadoses in excess of 1 gm daily of ascorbic acid.

Clinical Manifestations of Hypervitaminosis C

Urate, cystine, and oxalate stone development; gout
Abdominal cramps
Possible tooth enamel damage
Decrease of white blood count
Acute erythrocyte hemolysis
Osmotic diarrhea

Interference with anticoagulant therapy
Excess ascorbic acid excreted in the urine gives a false-positive test for sugar and fecal occult blood
Deficiency symptoms (rebound scurvy) may occur when megadose intake is abruptly discontinued
Electrolyte, acid-base imbalance

Nutrient/Drug Interactions

1. Cortisone and prednisone cause increased vitamin C excretion.
2. Nicotinic acid may increase vitamin C requirement.
3. ACTH depletes adrenal ascorbic acid.
4. Aspirin, alcohol, anorectic agents, anti-convulsants, and tetracycline deplete tissue ascorbic acid.
5. Oral contraceptives decrease the absorption, or stimulate the metabolism of ascorbic acid.

Questions and Answers

Q. What is the role of ascorbic acid in cancer?

A. There is very limited evidence in poorly designed and controlled studies which suggests that vitamin C can inhibit formation of some carcinogens and that vitamin C-containing foods are associated with a lower risk of cancer of the stomach and esophagus.[1]

Q. Will megadoses of vitamin C lower blood levels of cholesterol and protect against heart disease?

A. As of 1982, the bulk of scientific research offers no hope that extra vitamin C affects blood levels of cholesterol.

Q. Will excess ascorbic acid cause renal stones?

A. Vitamin C has been implicated in the formation of urate and oxalate stones,[2] but recent evidence shows that massive ascorbic acid intake of 9 gm daily produces only a small increase in urinary oxalate concentration and no change in urate[3]; ascorbic acid is metabolized to oxalate. Massive ascorbic acid intake can cause diarrhea, which may increase absorption of oxalate.

Q. Does vitamin C combat the nitrate hazard?

A. Vitamin C inhibits the oxidation of nitrite to nitrate. More research is needed to determine if higher levels of vitamin C are efficacious in prevention of cancer caused by nitrates. (See Module 19, Risk Factors and Disease Prevention, for additional discussion.)

Q. Will taking megadoses of vitamin C prevent or cure a cold?

A. At present, there is no scientific evidence that taking megadoses of ascorbic acid prevents colds. There is some evidence that vitamin C may cause a slight improvement in cold symptoms (vitamin C may act as an antihistamine), but not enough to justify megadoses that may be harmful. If an antihistamine effect is desired, available antihistamine drugs are far more useful.

Q. Is a good source of vitamin C needed daily?

A. Vitamin C is stored in the body. A good source of vitamin C, 3 to 4 times a week, is adequate to meet the needs of healthy non-smokers. Smokers will benefit from a good source of vitamin C daily.

Q. Do megadoses of ascorbic acid enhance athletic performance?

A. Controversies exist as to whether ascorbic acid intake enhances athletic performance. A recent study reported that a 300-mg ascorbic acid daily supplement appeared to have little effect on physical performance of healthy male subjects.[4]

Q. Will megadoses of vitamin C cause diarrhea in runners?

A. Many runners have been advised to take megadoses of ascorbic acid to lessen musculoskeletal symptoms. Such doses frequently produce diarrhea, the source of which may be unrecognized for some time.[5]

Q. What is the relationship between copper and ascorbic acid?

A. Megadoses of ascorbic acid (1500 mg daily for 64 days) has been shown to be antagonistic to copper. In one study, serum ceruloplasmin activity was significantly reduced. Excess vitamin C interferes with absorption of copper, and since copper is necessary for iron release, anemia may eventually result.[6]

Q. Will vitamin C cure male infertility?

A. A research study reports that 1 gm of ascorbic acid daily may restore fertility within a few days to men with infertility secondary to nonspecific sperm agglutination. Ascorbic acid apparently decreases the agglutination of the sperm and makes them more mobile. It also extends the life span of the sperm.[7]

B-Complex Vitamins

Thiamin

Chemical Names

Thiamin
Vitamin B_1

Functions

1. Functions as a coenzyme, thiamin pyrophosphate, in metabolism of carbohydrates, fats, and protein.
2. Essential in nucleic acid (DNA, RNA) synthesis.
3. Essential in fatty acid synthesis.
4. Promotes normal functioning of the nervous system.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in thiamin:

Pork	Fish
Liver	Dried peas and beans
Organ meats	Soybeans
Lean meat	Peanuts
Poultry	Whole grain cereals and breads
Egg yolk	Enriched cereals and breads

2. Daily RDAs (in mg)

Men = 1.2-1.5
Women = 1.0-1.1
Pregnancy = 1.4-1.5
Lactation = 1.5-1.6
Children = 0.7-1.4
Infants = 0.3-0.5

RDA based on 0.5 mg per 1000 kcal intake. Protein and fat intake may spare thiamin.

3. Laboratory Tests

Erythrocyte transketolase test
24-hour thiamin excretion (results expressed as function of creatinine excretion)

Major Causes of Hypovitaminosis Thiamin

1. Loss of thiamin due to excessive cooking or processing of food.
2. Others at risk for a thiamin deficiency are the elderly, alcoholics, the poor, individuals confined to institutions, and patients with long-term illness, sepsis, multiple surgeries, and hyperthyroidism.

Clinical Manifestations of Hypovitaminosis Thiamin

Early stage of deficiency	Fatigue Anorexia Indigestion Constipation Heavy, weak, numb legs Calf muscle tenderness Gastric atony, HCl deficiency
Wet beriberi	Tense calf muscles Fast pulse, hypertension Distended neck veins, generalized edema Decreased urine output
Dry beriberi	Worsening of polyneuritis of early stage with ataxia Wernicke-Korsakoff syndrome; encephalopathy may occur

Major Causes of Hypervitaminosis Thiamin

No toxicity effects are known except that amounts thousands of times larger than needed result in death by depression of the respiratory center. Anaphylactic shock in man is rare, but can occur when thiamin is given intravenously in large amounts.

Nutrient/Drug Interactions

Aluminum hydroxide and baking soda destroy thiamin. If a patient takes antacids daily, a daily multivitamin capsule which provides 100% of the RDA is needed.

Questions and Answers

Q. Are the elderly susceptible to thiamin deficiency?

A. A review by Iber, et al.,[1] indicates that poverty, along with old age and alcoholism, frequently combine to impair thiamin intake and utilization and often result in frank symptoms of deficiency.

Q. What is a recommended thiamin replacement when an alcoholic is admitted for acute care?

A. If dextrose solution is given, 100 mg B_1/day for three days should be administered. For Wernicke-Korsakoff syndrome, up to 500 mg to 1 gm IV for crisis therapy, followed by 100 mg b.i.d. for maintenance is recommended.[2]

Q. Should I take a thiamin supplement after having several alcoholic drinks?

A. If the patient is a "social" drinker, emphasize a variety of foods from the basic four food groups. If the individual is a moderate drinker, and food intake indicates a decrease in foods rich in B-complex, then a multiple vitamin and multiple mineral supplement should be recommended. If neuritis develops, daily parenteral injections of B_1, 100 mg or more, are recommended.[2]

Q. Should additional thiamin be taken during periods of stress and exercise?

A. No. Additional thiamin is not necessary. Recommend a diet with a variety of foods from the basic four food groups, emphasizing more servings from the grain group which is high in thiamin.

Riboflavin

Chemical Names

Riboflavin
Vitamin B_2

Functions

1. Functions as a coenzyme (FAD, FMN) to catalyze reactions in cell mitochondria to produce ATP (energy) from carbohydrate, protein, and fat.
2. Essential for growth, vision, red blood cell synthesis, thyroid hormone, and corticosteroid synthesis.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in riboflavin:

   Milk
   Cheese
   Liver, kidney
   Lean meats
   Eggs
   Green leafy vegetables
   Enriched breads and cereals

2. Daily RDAs (in mg)

   Men = 1.4-1.6
   Women = 1.2-1.3
   Pregnancy = 1.5-1.6
   Lactation = 1.7-1.8
   Children = 0.8-1.4
   Infants = 0.4-0.6

   RDA based on 0.6 mg per 1000 kcal intake. Requirements probably relate more to body mass than calorie intake.

3. Laboratory Tests

   Erythrocyte glutathione reductase activity
   24-hour urinary excretion of riboflavin (expressed in relation to creatinine excretion)

Major Causes of Hypovitaminosis Riboflavin

1. Limited dietary intake of milk and milk products, animal protein, and leafy vegetables.
2. Faulty utilization and/or poor absorption, prolonged fever, sepsis, hyperthyroidism, multiple surgeries.

Clinical Manifestations of Hypovitaminosis Riboflavin

Ariboflavinosis
Soreness and burning of lips, mouth, and tongue*
Cheilosis*
Angular stomatitis*
Glossitis*
Purplish or magenta tongue*
Dermatitis of nasolabial folds, nose, ears and eyelids, scrotum, and vulva
Ocular disorders
Anemia — normocytic and normochromic
Neuropathy
Fatty liver
Hypoglycemia

*Tongue and mouth changes are difficult to differentiate from those in niacin, folic acid, thiamin, vitamin B_6, or vitamin B_{12} deficiency.

Major Cause of Hypervitaminosis Riboflavin

No toxicity for riboflavin is known.

Nutrient/Drug Interactions

Thiazides increase urinary excretion of riboflavin; oral contraceptives decrease absorption.

Questions and Answers

Q. Should supplementation of riboflavin be provided if taking oral contraceptives?

A. Supplementation is not necessary unless the diet does not meet the recommended servings from the basic food groups.

Q. If my patient has cheilosis, stomatitis, or glossitis, should I automatically prescribe riboflavin supplementation?

A. When skin changes occur, especially around the tongue and mouth, suggesting a nutrient deficiency, it is better to prescribe a multiple vitamin-mineral supplement, instead of a specific nutrient supplement. Deficiencies of vitamins and minerals usually occur together instead of being isolated cases.

Niacin

Chemical Names

Niacin
Nicotinic Acid
Nicotinamide

Function

Functions as a coenzyme (NAD, NADP) in fat synthesis, glycolysis, ATP production, and alcohol metabolism.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in niacin and/or tryptophan:

   Milk
   Eggs
   Lean meat
   Organ meat
   Poultry
   Fish
   Brewer's yeast
   Peanuts
   Peanut butter
   Enriched whole grain cereals and breads

2. Daily RDAs [in mg N.E. (niacin equivalent)]

   Men = 18-19
   Women = 13-15
   Pregnancy = 15-17
   Lactation = 18-20
   Children = 9-16
   Infants = 6-8

   RDA for adults based on 6.6 mg Niacin Equivalents (N.E.) per 1000 kcal intake. Tryptophan can contribute to N.E. (60 mg tryptophan = 1 mg niacin). An approximation of tryptophan can be made by assuming that dietary protein contains one percent tryptophan.

3. Laboratory Tests

   24-hour Urinary N-methyl nicotinamide
   (expressed per gram urinary creatinine)
   Z-pyridone test

Major Cause of Hypovitaminosis Niacin

Limited dietary intake of milk and animal products or when dietary intake consists mainly of corn as a staple of the diet. At risk are the poor, alcoholics who do not eat, and poverty-induced tuberculosis patients receiving Isoniazid.

Clinical Manifestations of Hypovitaminosis Niacin (Pellagra)

Dermatitis
GI symptoms
  Diarrhea
  Anorexia
  Indigestion
  Sore mouth
  Inflammed gut and mouth membranes
CNS and mental changes
  Tremors
  Neuritis
  Confusion, lassitude
  Muscle weakness
  Irritability
  Dementia

Major Cause of Hypervitaminosis Niacin

Excessive intake of niacin, self-induced or prescribed for treatment of cardiovascular disease, schizophrenia, lassitude, or other common disorders.

Clinical Manifestations of Hypervitaminosis Niacin

No toxicity reported for nicotinamide
Megadoses of nicotinic acid cause
  Skin flushing
  Headaches
  Hypertension
  Increased basal metabolic rate
  Tingling of extremities
  GI tract irritation
  Possible liver damage
  High blood sugar
  Increased uric acid levels

Nutrient/Drug Interactions

1. Isoniazid causes niacin depletion.
2. Estrogens increase rate of conversion of tryptophan to niacin, thereby altering tryptophan metabolism. Although oral contraceptives seem to alter absorp-

tion and metabolism of many nutrients, there is little evidence that women using this medication require increased amounts of nutrients to prevent nutritional deficiencies. If, however, a dietary evaluation reveals that a patient's diet is marginal, malnutrition may occur. Give one multi-vitamin/mineral supplement equal to 100% RDA daily unless diet can be improved.

Questions and Answers

Q. Is niacin helpful in lowering serum cholesterol and triglycerides?

A. The benefits of long-term use (3 to 6 gm/day) may be worthwhile for hypercholesterolemia; however, the side effects and possible toxicity may limit its use for this purpose to a "second step" drug. Some physicians do use it, along with aspirin, to limit side effects, as we become increasingly aware of the dangers of hyperlipidemia. It can be particularly helpful for elevated cholesterol levels in conjunction with a bile-acid sequestrant drug.

Q. Is niacin toxic?

A. Yes. There are two forms of niacin. Niacinamide is used for the treatment of pellagra and is rarely toxic. Nicotinic acid is more useful for hypercholestrolemia and causes the release of histamine. Histamine causes dilation of blood vessels, flushing of skin, and other symptoms, which can occur within 15 minutes after taking as much as five times the RDA. A prostaglandin blocker, such as aspirin, plus niacin may decrease the toxic effect of niacin. The side effects of nicotinic acid may also be limited by starting at a low dose, such as 100 mg b.i.d., and increasing gradually to a more effective dose. It should not be used by patients with diabetes or gout.

Q. Will niacin aid in the treatment of schizophrenia?

A. Niacin was one of the first vitamins to be used in megadoses for schizophrenia, because some of the mental disturbances of schizophrenia resembled those seen in pellagra. There is a lack of evidence for this treatment, and the controversy continues as to its efficacy.

Pyridoxine

Chemical Names

Pyridoxine
Vitamin B_6
Pyridoxal phosphate
Pyridoxamine

Functions

1. Functions as a coenzyme (pyridoxal phosphate) involved in protein metabolism and release of glycogen from liver and muscle.
2. Assists in conversion of tryptophan to niacin.
3. Synthesis of porphyrins, catecholamines, and serotonin.
4. Maintenance of cellular immunity.
5. Synthesis of sphingolipids and myelin sheath.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in pyridoxine:

   Wheat germ
   Pork
   Liver
   Whole grains
   Soybeans
   Meat
   Legumes
   Potatoes
   Bananas
   Oatmeal
   Nuts
   Yeast

2. Daily RDAs (in mg)

   Men = 1.8-2.2
   Women = 1.8-2.0
   Pregnancy = 2.4-2.6
   Lactation = 2.3-2.5
   Children = 0.9-1.3
   Infants = 0.3-0.6

   Requirement increases as protein intake increases.

3. Laboratory Tests

   Tryptophan load test is best to use
   Serum transaminase (SGOT, SGPT)
   Urinary pyridoxine
   Serum pyridoxine

Major Causes of Hypovitaminosis Pyridoxine

At risk are those persons who are in poverty, cannot purchase or eat meat, chronically ill, on mul-

tiple medications, and the elderly poor, alcoholic poor, and ignorant poor.

Clinical Manifestations of Hypovitaminosis Pyridoxine

Kidney problems include increased urinary oxalate, increased urea excretion, and renal stone formation
Weakness, insomnia, depression
Anemia, dermatitis
Peripheral neuritis, muscle twitching
Impaired immune response
GI symptoms: vomiting, cheilosis, glossitis, stomatitis

Major Cause of Hypervitaminosis Pyridoxine

Excessive intake or injection (100 mg) of B_6.

Clinical Manifestations of Hypervitaminosis B_6

Sleepiness
Liver damage
Tingling sensations
Unsteady walking
Numb feet[2]
Clumsy hand coordination.

Nutrient/Drug Interactions

1. Corticosteroids and penicillamine increase metabolic needs for B_6.
2. Cycloserine decreases absorption of B_6.
3. Isoniazid antagonizes vitamin B_6.
4. Levodopa causes increased peripheral breakdown of B_6.
5. Oral contraceptives decrease absorption.[3]

Questions and Answers

Q. Can vitamin B_6 ease premenstrual syndrome (PMS) problems?

A. There is some evidence that B_6 may be effective in treatment of PMS but more research is needed to determine circumstances under which it should be used and at what dosage. Megadoses greater than 500 mg/day of pyridoxine have been reported to be harmful.

Q. What is a megadose of B_6, and how is it harmful?

A. A megadose is considered to be about 200 mg daily. Liver damage and impairment to the nervous system are potential problems created by megadoses of B_6.

Q. Why might a B_6 deficiency occur when taking isoniazid?

A. It is believed that isoniazid competes with pyridoxal phosphate for the enzyme apotryptophanase. Pyridoxine in doses of 50 to 100 mg (range 15 to 300 mg) daily in adults may be administered concurrently with isoniazid to help prevent or minimize the symptoms of peripheral neuritis.[4]

Q. What is the role of B_6 when high-dose Ara-C, a chemotherapeutic drug, is given to a patient?

A. Ara-C causes the skin to discolor and become scaly similar to that of a patient suffering from pellagra. B_6 may alleviate this problem. At present no references are available to substantiate this observation.

Q. Is the amount of B_6 found in multivitamin tablets harmful?

A. The RDA for adults is 1.8-2.2 mg/day. Most multivitamin capsules contain 100% of the RDA. A few of the megavitamin-stress tablets contain 50 to 100 mg of B_6, which is probably not harmful if only one tablet per day is consumed.

Biotin

Chemical Name

Biotin

Function

As a coenzyme involved in fat synthesis, amino acid metabolism, glycogen formation, gluconeogenesis, and cholesterol synthesis.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in biotin:

   Liver
   Peanuts
   Milk
   Egg yolk
   Soybeans
   Fruits
   Meat
   Yeast

   Synthesized in the intestinal tract

2. Daily RDAs (in μg) are not established; safe and adequate daily intakes as follows:

Adults = 100-200
Children = 65-120
Infants = 35-50

Average daily intake = 100-300μg/day

3. Laboratory Tests

Urinary biotin
Whole blood biotin

Major Causes of Hypovitaminosis Biotin

1. Can occur by eating about 12 raw egg whites daily for several weeks.
2. Biotin-deficient diet.
3. Decreased activity of intestinal bacteria.

Clinical Manifestations of Hypovitaminosis Biotin

Increased skin sensitivity, dermatitis
Depression
Fatigue
Conjunctivitis
Progressive loss and color of hair
ECG changes, hypocholesterolemia
Anorexia, nausea

Major Causes of Hypervitaminosis Biotin

No known toxic effects.

Nutrient/Drug Interactions

None identified

Question and Answer

Q. Will biotin prevent balding or aging?

A. There is no scientific evidence that biotin will prevent balding or aging.

Pantothenic Acid

Chemical Name

Pantothenic Acid

Functions

1. Part of coenzyme A involved in energy metabolism.
2. Synthesis of cholesterol, steroid hormones, and porphyrin.
3. Synthesis of phospholipids, ketones, and fatty acids.
4. Metabolism of some amino acids.
5. Degradation of alcohol.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in pantothenic acid:

Excellent sources are

Eggs	Whole-grain cereals
Liver	Salmon
	Yeast

Present in all plant and animal tissue, in fact, its name means "widespread"; possible synthesis by intestinal flora.

2. Daily RDAs (in mg) not established; safe and adequate daily intake as follows:

Adults = 4-7
Children = 3-5
Infants = 2-3

Normal diet = 10-15 mg/day

3. Laboratory Test

Urinary pantothenic acid

Major Causes of Hypovitaminosis Pantothenic Acid

1. Dietary deficiency is rare since it is found in most foods.
2. Korsakoff's syndrome.
3. Chronic ulcerative colitis.

Clinical Manifestations of Hypovitaminosis Pantothenic Acid

When antagonists are given, may cause "burning feet syndrome" with spastic gait
GI symptoms include anorexia, nausea, cramps, and ulcers
Loss of cellular immunity, leukopenia
Adrenal gland malfunction, insomnia, fatigue, and growth retardation

5. Anemia
6. Hypoglycemia

Major Causes of Hypervitaminosis Pantothenic Acid

No toxic effects are known.

Nutrient/Drug Interactions

None identified

Question and Answer

Q. Will pantothenic acid prevent graying of hair?

A. Although pantothenic acid prevents graying of fur in animals, it has not been shown to prevent gray hair in man.

Folacin

Chemical Names

Folacin
Folic Acid
Pteroylmonoglutamate

Functions

1. As coenzyme (tetrahydrofolate) in synthesis of DNA, RNA, purines, pyrimidines, heme, RBC, WBC.
2. Controls macrocytic anemia of infancy, pregnancy, and sprue.
3. Corrects pernicious anemia but not neurological lesions.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in folacin:

   Liver
   Kidney and lima beans
   Fruits
   Dark green leafy vegetables
   Whole grain products
   Beef
   Potatoes

2. Daily RDAs (in μg)

   Men = 400
   Women = 400
   Pregnancy = 800
   Lactation = 500
   Children = 100-300
   Infants = 30-45

   Alcohol increases requirement

3. Laboratory Tests

   Serum folacin

   FIGLU (formiminoglutamic acid) test. Folacin is needed for the conversion of histidine to glutamic acid. When metabolism of histidine is impaired, FIGLU accumulates and is excreted in the urine.

Major Causes of Hypovitaminosis Folacin

1. Inadequate dietary intake if patients are unable to purchase or to ingest fruits or vegetables.
2. Impaired absorption as in sprue and gluten-induced enteropathy.
3. Alcoholism
4. Protein malnutrition
5. Use of anticonvulsants and oral contraceptives

Clinical Manifestations of Hypovitaminosis Folacin

Poor growth

Megaloblastic anemia of pregnancy

Irritability, forgetfulness

GI disturbances, glossitis, diarrhea

Major Causes of Hypervitaminosis Folacin

No toxicity known; large doses will antagonize anticonvulsants and may result in seizure activity.

Nutrient/Drug Interactions

Aspirin, barbiturates, salicylazosulfapyridine, and oral contraceptives decrease absorption of folic acid.

Triamterene impairs utilization of folic acid.

Questions and Answers

Q. Should patients taking Dilantin supplement their diets with folate?

A. Large doses of folacin will antagonize anticonvulsants, possibly leading to epileptic seizures. The diet should provide the RDA of folic acid.

Q. Is folate supplementation contraindicated with Methotrexate in the treatment for cancer or leukemia?

A. If an excess amount of folic acid is given, it will act as an antidote to lessen desired toxicity of Methotrexate to the tumor cells.

Cobalamin

Chemical Names

Cobalamin
Vitamin B_{12}
Cyanocobalamin

Functions

1. Extrinsic factor of food essential in treatment/prevention of pernicious anemia.
2. Synthesis of nucelic acids.
3. Essential in carbohydrate, fat, and protein metabolism.
4. Essential in synthesis of folate.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods which are high in cobalamin:

   Liver
   Kidney
   Poultry
   Milk
   Eggs
   Meat
   Fish
   Cheese
   Not found in foods of plant origin

2. Daily RDAs (in μg)

   Men = 3.0
   Women = 3.0
   Pregnancy = 4.0
   Lactation = 4.0
   Children = 2.0-3.0
   Infants = 0.5-1.5

3. Laboratory Tests

   Schilling test
   Serum B_{12}

Major Causes of Hypovitaminosis Cobalamin

1. Absence of intrinsic factor after resection of stomach.
2. Malabsorption syndromes such as sprue, ZE syndrome, bacterial overgrowth, diverticulitis, ilectomy, and ileitis.
3. Vegetarian whose intake is exclusively vegetables.
4. Alcoholism.
5. Blind loop syndrome.

Clinical Manifestations of Hypovitaminosis Cobalamin

Pernicious anemia (megaloblastic)
Neurological damage to spinal cord
Lhermitte's sign[5]
Mental disorders (psychoses, hallucinations)

Major Causes of Hypervitaminosis Cobalamin

No toxic effects are known.

Nutrient/Drug Interactions

Oral contraceptives, Methotrexate and other cytotoxic medications, neomycin, colchicine, and clofibrate decrease absorption.

Question and Answer

Q. Will B_{12} provide a quick source of energy and prevent aging and senile dementia in the elderly?

A. These are popular claims for B_{12}, but there is no evidence as yet to validate these claims. The B-complex vitamins are part of enzyme systems necessary for oxidation of food and production of energy. If a person is deficient in one or more members of the vitamin complex, a tired feeling may result. However, if body cells contain adequate B-vitamins, more B-vitamins will not increase energy levels.

Trace Minerals

Chromium

Chemical Name

Chromium

Functions

1. Cofactor with insulin at the cellular level.
2. Constituent of proteolytic enzymes.
3. Essential in glucose utilization for lipogenesis.
4. Essential for glycogen and cholesterol synthesis.
5. Essential for incorporation of amino acids into protein.
6. Essential for growth.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in chromium:

   Oysters
   Brown sugar
   Bran
   Brewer's yeast
   Whole grain breads and cereals
   Meats
   Clams
   Natural cheeses
   Liver
   Egg yolks

2. Daily RDAs (in mg) are not established; safe and adequate daily intake as follows:

   Adults = 0.05-0.2
   Children and adolescents = 0.02-0.2
   Infants = 0.01-0.06

3. Laboratory Tests

    24-hour urine chromium excretion
    Serum chromium

Major Causes of Deficiency

1. Marginal deficiency state may exist in U.S. elderly population.
2. Pregnant women with numerous previous pregnancies.
3. Protein-calorie malnutrition.
4. Reduced dietary intake with highly refined foods.

Clinical Manifestations of Deficiency

Decreased glucose tolerance
Insulin resistance
Decreased growth
Disturbance in protein metabolism
Increased blood lipids
Peripheral neuropathy, ataxia

Major Cause of Toxicity

Exposure to chromium dust or solutions.

Clinical Manifestation of Toxicity

May have immune suppressive effect

Nutrient/Drug Interactions

None identified

Questions and Answers

Q. Will chromium supplementation prevent atherosclerosis?

A. A number of investigators have reported that supplementation with chromium has lowered blood cholesterol in elderly subjects. Supplementation was either with inorganic chromium or as Brewer's yeast. A balanced and varied diet is likely to furnish adequate chromium.[1] Chromium supplementation should be used only under the direction of a physician.

Q. Will chromium prevent diabetes mellitus in elderly individuals?

A. It has been suggested that some elderly persons with diabetes may be chromium deficient; efforts have been made to correct the glucose intolerance by increasing chromium intake. Chromium-rich Brewer's yeast has improved glucose tolerance and insulin sensitivity in elderly subjects who may have been marginally chromium deficient; however, more research is needed to establish the role of chromium in the prevention of diabetes.[2]

Copper

Chemical Name

Copper

Functions

1. Essential for hemoglobin synthesis and iron mobilization.
2. Essential for bone mineralization and connective tissue metabolism.
3. Essential in myelin sheath and phospholipid integrity, and function of central nervous system.
4. Essential in melanin formation.
5. Activator of several enzymes.
6. Essential in electron transport system.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in copper[1]:

    Liver
    Kidney
    Drinking water
    Oysters
    Legumes
    Nuts
    Cocoa
    Whole grain breads and cereals
    Raisins

    Copper is widely distributed in food.

2. Daily RDAs (in mg) are not established; safe and adequate daily intakes as follows:

    Adults = 2.0-3.0
    Children and Adolescents = 1.0-2.5
    Infants = 0.5-1.0

3. Laboratory Tests

    Serum copper
    Serum ceruloplasmin

Major Causes of Deficiency

1. Nephrotic syndrome.
2. Malabsorption syndromes.
3. Parenteral hyperalimentation of infants.
4. High-fiber diets decrease copper absorption.

Clinical Manifestations of Deficiency

Anemia: hypochromia, normocytic

Skeletal problems, including poor bone mineralization
Neonatal ataxia
Decreased collagen synthesis
Osteoporosis
Infertility
Cardiovascular disease
Poor growth
Neutropenia
Severe deficiency is rare in adults; copper deficiency has been observed in infants with chronic diarrhea and malabsorption or on a diet consisting almost exclusively of milk
Menke's Kinky Hair Syndrome (abnormal hair pigmentation)

Major Causes of Toxicity

1. Wilson's disease—excessive copper accumulation in tissues, probably due to decreased biliary excretion of copper.
2. Liver disease.
3. Pellagra.

Clinical Manifestations of Toxicity

Anemia
Hemochromatosis
Hypercupremia
Bronze skin color
Bronze ring around iris
Metallic taste
Epigastric pain

Nutrition/Drug Interactions

None identified

Questions and Answers

Q. Will wearing a copper bracelet prevent illnesses and copper deficiency?

A. The bracelet has no effect in preventing any type of illness. Copper deficiency has not been described in adult humans because almost any diet contains the several milligrams daily that are necessary to prevent a deficiency.

Q. Does copper need to be given to patients with biliary disease?

A. No, because bile is the primary route for excretion of copper. If there is insufficient bile, copper will accumulate in the liver.

Fluorine

Chemical Name

Fluorine as fluoride

Functions

1. Essential part of tooth enamel.
2. Provides stability and resistance to bone and tooth demineralization.

Nutritional Assessment Guidelines

1. Evaluate dietary intake of water and the following foods high in fluoride:

   Mackerel
   Sardines
   Liver
   Salmon
   Beef
   Chicken
   Eggs

2. Unintentional ingestion of toothpaste
3. Daily RDAs

   Not established

4. Laboratory Test(s)

   None established

Major Cause of Deficiency

Inadequate ingestion of fluoridated water or foods high in fluoride.

Clinical Manifestations of Deficiency

Dental caries
Bone demineralization

Major Causes of Toxicity

1. Dental fluorosis (mottled teeth) is caused by an intake of water with fluoride in excess of 1.5 ppm (parts per million). This results in defective calcification and tooth structure; enamel develops a spotted, chalky white appearance which undergoes secondary brownish discoloration.
2. Osteosclerosis is the hardening or abnormal density of bone as in eburnation and condensing osteitis. This condition may occur at fluoride concentrations of 8 to 20 ppm in water.

Clinical Manifestations of Toxicity

Weakness
Weight loss
Joint stiffness

Brittle bones
Anemia
Discoloration of teeth during tooth formation

Nutrient/Drug Interactions

None identified

Questions and Answers

Q. Does fluoride prevent osteoporosis in later life?

A. Osteoporosis may be reduced in areas where fluoride intake is adequate or even excessive. Increased retention of calcium, accompanied by a reduction in bone demineralization, is observed in patients receiving fluoride salts. Fluoride appears to stimulate osteoblastic activity thereby increasing bone mass.[1] At present, fluoride may be considered for treatment regimens in osteoporosis, but it should not be used in preventive care of patients.

Q. Is fluoride toxic and a cause of cancer?

A. There is no reliable evidence that ill effects will result from drinking fluoridated water at the recommended level (1 ppm). Although this is a regular concern of health food quacks, there have been no studies to indicate that fluoride is a cause of cancer.

Iodine

Chemical Name

Iodine as iodide

Function

Constituent of thyroid hormones which influence basal metabolism, growth, and neuromuscular and central nervous system functioning.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in iodide:

   Seafood
   Fish
   Iodized salt
   Bread

2. Daily RDAs (in μg)

   Men = 150
   Women = 150
   Pregnancy = 175
   Lactation = 200
   Children = 70-120
   Infants = 40-50

3. Laboratory Tests

   Thyroid function tests

Major Causes of Deficiency

1. Lack of iodine in diet
2. Dietary goitrogens include cabbage family vegetables, rutabagas, turnips, and soybeans; cooking inactivates goitrogens

Clinical Manifestations of Deficiency

Goiter and myxedema

Symptoms include sluggishness, apathy, slowed breathing, decreased reproduction, sterility, decreased thyroid function, free thyroxine in blood, and decreased basal metabolic rate

Major Causes of Toxicity

1. Medications
2. Excessive use of iodized salt

Clinical Manifestations of Toxicity

Thyrotoxicosis, Grave's Disease

Symptoms include nervousness, irritability, muscle tremors, sweating, increased basal metabolic rate, and emotional instability

Nutrient/Drug Interactions

Antithyroid drugs include thiocyanate, perchlorate, lithium, propylthiouracil, PAS, sulfonamide

Question and Answer

Q. Should I use iodized salt as the major source of iodine in my diet?

A. Although the incidence of goiter has decreased in the U.S. population in recent decades, the use of iodized salt is necessary to prevent goiter in people living in mountainous areas, the upper tier of states, distant from the sea shore, and exclusively consuming foods grown in these areas.

Iron

Chemical name

Iron

Functions

1. Constituent of hemoglobin, myoglobin, oxidative phosphorylation, cytochromes, cytochrome oxidase.
2. Essential in heme molecule in oxygen and electron transport.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in iron:

   Liver
   Meat
   Egg yolk
   Legumes
   Dried fruits
   Enriched breads and cereals
   Dark green leafy vegetables
   Broccoli
   Greens
   Molasses

2. Daily RDAs (in mg)

   Men = 10-18
   Women = 10-18
   Pregnancy and lactation require enteral iron supplementation of 30-60
   Children = 10-15
   Infants = 10-15

3. Laboratory Tests

   Serum iron
   Serum hemoglobin and hematocrit
   Red blood cell indices
   Iron-binding capacity
   Plasma ferritin[1]
   Red cell protoporphyrin[1]
   Transferrin saturation[1]

Major Causes of Deficiency

1. Inadequate iron absorption due to sprue or gastric surgery.
2. Blood loss.
3. Inadequate intake of foods high in iron.
4. Infections.
5. Long-term chronic illnesses.
6. Alcoholism.
7. Pregnancy and lactation.
8. Growth.
9. Extensive exercise.

Clinical Manifestations of Deficiency

Anemia, hypochromic, microcytic
Malaise, irritability
Decline in work capacity, shortness of breath
Dysphagia, stomatitis
Decreased resistance to infection
Nail clubbing

Major Causes of Toxicity

1. Excess intake via supplement or TPN.
2. Idiopathic hemochromatosis.
3. Chronic alcoholism.
4. Chronic liver disease.
5. Transfusional hemosiderosis.

Clinical Manifestations of Toxicity

Skin discoloration; bronze diabetes
Severe liver disease
Pancreatic insufficiency, diarrhea
Metabolic acidosis
Renal failure
Mucosal ulceration and bleeding
Interference with absorption of copper, zinc, and manganese

Nutrient/Drug Interactions

1. Ascorbic acid facilitates iron absorption.
2. Maalox decreases absorption of iron if gastric content is not kept acidic.
3. Neomycin and tetracycline decrease absorption of iron.
4. Oral contraceptives increase iron absorption.
5. Iron preparations may cause black or dark green stools, constipation, or diarrhea; if there is gastric distress, give iron medications after meals.

Questions and Answers

Q. Will iron-fortified cereals provide my daily requirement for iron?

A. If the cereal has iron-rich raisins, prunes, or apricots, it will provide additional iron to meet daily needs. Nearly all (90%) cereals are fortified with ferrous iron which is well-absorbed.

Q. Is it necessary to take additional iron during menstruation?

A. Not unless iron-deficiency is diagnosed. Iron loss in normal menses may amount to 10 to 30 mg/month. Added to loss of iron from sweat, urine, and feces, the total iron loss in non-pregnant women averages about 43 mg/month. If losses are excessive, iron deficiency anemia can result; however, prophylactic iron therapy is not warranted unless diagnosis of anemia is made.[2]

Q. Do babies and young children need iron supplementation?

A. Normal-term infants should receive 1 mg of supplemental iron per kg of body weight per day starting at about 4 months of age to meet requirements during rapid growth. Infants of low birth-weight should receive up to 2 mg/kg of body weight of supplemental iron per day about 5 to 6 weeks after birth; dose then is gradually reduced to 1 mg/kg body weight per day.[3]

Q. Should women participating in athletics take iron supplements?

A. Even though there is a decrease in serum iron, hemoglobin, and hematocrit levels in many women athletes, this is usually not a true deficiency, and iron supplementation should not be given unless serum ferritin is decreased. A low serum ferritin indicates iron storage to be low and probably iron deficiency. A decreased hemoglobin/hematocrit occurs with exercise because training tends to increase red blood cell mass by approximately 18% and plasma volume by about 31%,[4] thus, creating a hemodilution effect. Therefore, it is important to check storage of iron in order to tell if iron deficiency has or has not occurred before prescribing iron supplements.[5]

Magnesium

Chemical Name

Magnesium

Functions

1. Serves as activator of many enzyme systems.
2. Component of bone, teeth, and other tissues.
3. Affects nerve and muscle irritability.
4. Essential in protein synthesis.
5. Essential in potassium and calcium balances.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in magnesium:

   Vegetables
   Whole grain cereals and breads
   Nuts
   Legumes
   Meat
   Seafood
   Milk
   Seeds

2. Daily RDAs (in mg)

   Men = 350-400
   Women = 300
   Pregnancy = 450
   Lactation = 450
   Children = 150-250
   Infants = 50-70

3. Laboratory Test

   Serum magnesium

Major Causes of Deficiency

1. Renal failure.
2. Ethanol abuse.
3. Prolonged losses via GI secretions.
4. Diabetic ketoacidosis.
5. Long-term diuretic use.
6. Cirrhosis.
7. Inadequate parenteral nutrition.
8. Hyperthyroidism.
9. Burns.

Clinical Manifestations of Deficiency

Tremors, neuromuscular irritability, Chvostek's sign, seizures, hallucinations, refractory hypokalemia and hypocalcemia, and failure to thrive. A fall in serum magnesium may be secondary to elevated free fatty acids and may cause cardiac irritability, including ventricular and supraventricular irritability, and sudden death.

Major Causes of Toxicity

1. Hyperparathyroidism.
2. Aldosterone deficiency.
3. Renal failure with antacid ingestion.

Clinical Manifestations of Toxicity

Cathartic effect
Transient hypotension
Respiratory depression
Coma
Paralysis
Loss of deep tendon reflex

Nutrient/Drug Interactions

1. Diuretics increase urinary excretion.
2. Oral contraceptive agents decrease absorption of magnesium.

Question and Answer

Q. Is magnesium lost when cooking vegetables?

A. Magnesium may be lost in cooking since it is an essential constituent of chlorophyll. It is best to cook the vegetables with the lid off for first 2-3 minutes in order to allow hydrogen ions to escape. If this does not occur, the hydrogen replaces magnesium and the magnesium is lost into the cooking water.

Manganese

Chemical Name

Manganese

Functions

1. Can substitute for magnesium in some enzyme reactions.
2. Activates many enzymes.
3. Essential in oxidative phosphorylation reactions.
4. Essential in cholesterol synthesis.
5. Essential for mucopolysaccharide synthesis in bone growth.
6. Maintains structure and function of pancreatic beta-cells.
7. Needed for reproduction and central nervous system function.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in manganese:

   Wheat germ
   Whole grain cereals and breads
   Nuts
   Legumes
   Tea
   Cloves
   Leafy green vegetables
   Blueberries

2. Daily RDAs (in mg) are not established; safe and adequate daily intake as follows:

   Adults = 2.5-5.0
   Children and Adolescents = 1.0-2.5
   Infants = 1.0-2.0

3. Laboratory Tests

   Serum manganese
   Urine manganese

Major Causes of Deficiency

1. Intestinal malabsorption.
2. Increased loss from vomiting and diarrhea.
3. Shift in electrolyte balance.

Clinical Manifestations of Deficiency

Anorexia
Growth failure
ECG changes
Nervous instability
Abnormal glucose tolerance
Hair color change

Major Causes of Toxicity

Least toxic trace mineral; toxicity is rare.

Clinical Manifestations of Toxicity

Psychological disorder resembling schizophrenia
Anemia
Pulmonary changes
Asthenia
Impotence
Leg cramps
Speech disturbances

Nutrient/Drug Interactions

None identified

Question and Answer

Q. Are manganese supplements necessary?

A. A deficiency does not appear to develop in humans unless a deliberate attempt is made to eliminate this mineral from the diet. A normal diet should prevent and/or correct any deficiency if whole grains and vegetables are consumed.

Molybdenum

Chemical Name

Molybdenum

Functions

1. Constituent of enzymes (including xanthine oxidase).
2. Influences utilization of copper.
3. An unequivocal requirement for human growth and maintenance has not been determined.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in molybdenum (concentration in foods varies according to soil content):

   Dark green leafy vegetables
   Whole grain cereals and breads
   Legumes
   Milk
   Eggs
   Liver

2. Daily RDAs (in mg) are not established; safe and adequate daily intakes as follows:

   Adults = 0.15-0.5
   Children and Adolescents = 0.05-0.15
   Infants = 0.03-0.08

3. Laboratory Test

   Urine molybdenum

Major Causes of Deficiency

Molybdenum deficiency has not been observed in humans except those receiving inadequate molybdenum in TPN solutions.

Clinical Manifestations of Deficiency

Abnormal purine degradation
Headaches, visual changes
Tachycardia
Lethargy
Irritability

Major Cause of Toxicity

Mining of ore

Clinical Manifestation of Toxicity

Gout-like syndrome with elevated blood molybdenum, uric acid, xanthine oxidase, and elevated urinary copper if daily molybdenum intake is greater than 10-15 mg.

Nutrient/Drug Interactions

None identified

Question and Answer

Q. Will molybdenum prevent heart disease because of its relationship to xanthine oxidase?

A. A recurrent theory implicates the enzyme xanthine oxidase of bovine homogenized milk as being the etiologic agent for the development of the initial lesion of atherosclerosis.[1] Currently, there are no available scientific data to support this hypothesis.

Selenium

Chemical Name

Selenium

Functions

1. Replaces sulfur in sulfur-containing compounds in tissues.
2. Component of myoglobin, cytochrome C, myosin, and nucleoproteins.
3. Acts synergistically with vitamin E as a non-specific antioxidant to protect membranes and tissues against peroxidation.
4. Essential to function of glutathione peroxidase (an enzyme that protects polyunsaturated fatty acids from peroxidation).

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in selenium (variations in selenium analysis of foods reflect differences in selenium content of soil):

   Meats
   Brewer's yeast
   Whole grain cereals and bread
   Onions
   Eggs
   Seafoods
   Organ meats
   Dairy products

2. Daily RDAs (in mg) are not established; safe and adequate daily intake as follows:

   Adults = 0.05-0.2
   Children and Adolescents = 0.02-0.2
   Infants = 0.01-0.06

3. Laboratory Test

   Urine selenium

Major Causes of Deficiency

1. Eating solely foods grown in areas where the soil is low in selenium; e.g., Amish areas in Ohio and Pennsylvania.
2. Eating a total vegetarian diet.

Clinical Manifestations of Deficiency

Myalgia
Muscle tenderness
Increased red blood cell fragility
Pancreatic degeneration
Growth retardation
Cardiomyopathy; gallop and heart enlargement seen in Chinese children[1]

Major Causes of Toxicity

1. Mineral is highly toxic.
2. Eating foods grown in high seleniferous soils.
3. Exposure to selenium in manufacturing of paints, photoelectric equipment, and refining of copper.

Clinical Manifestations of Toxicity

Chronic dermatitis
Excessive fatigue
Dizziness
Liver damage
Dental caries
Anorexia
Impaired vision
Paralysis

Nutrient/Drug Interactions

None identified

Questions and Answers

Q. Should selenium supplements be recommended for adults?

A. There is no justification for the general use of selenium supplements since the American diet furnishes about 60-150 μg daily. It must be emphasized that selenium is highly toxic and that excessive intake can be lethal.

Q. Will megadoses of selenium (250-300 μg/day) decrease the possibility of human cancer?

A. There is no reasonable evidence that selenium will protect against or cure human cancer.

Q. Does selenium help prevent heart disease?

A. There is little evidence that doses of selenium greater than the 50-200 μg daily found in the American diet will prevent or cure heart disease.

Q. Is selenium carcinogenic?

A. It was once thought to be, but this was never substantiated. Selenium, which is now included in animal feeds, was once limited because of its possible carcinogen effect.

Zinc

Chemical Name

Zinc

Functions

1. Component of enzymes, insulin, and metalloproteins.
2. Essential for vitamin A function.
3. Enhances protein synthesis, nucleic acid metabolism, and cellular immune response.
4. Essential for growth and tissue repair.
5. Plays a role in collagen formation, glycolysis, oxidative phosphorylation, and alcohol metabolism.

Nutritional Assessment Guidelines

1. Evaluate dietary intake for the following foods high in zinc:

   Shellfish
   Seafood
   Liver
   Meat
   Eggs
   Wheat germ
   Yeast
   Oysters
   Milk
   Nuts

2. Daily RDAs (in mg)

   Men = 15
   Women = 15
   Pregnancy = 20
   Lactation = 25
   Children = 10
   Infants = 3-5

3. Laboratory Tests

   Serum or plasma zinc
   Urine zinc
   Erythrocyte zinc

Major Causes of Deficiency

1. Crohn's disease.[1]
2. Trauma.
3. Burns.
4. Diets limited largely to whole wheat bread and beans; these foods contain phytate which binds zinc and decreases its absorption.
5. Acrodermatitis enteropathica (A.E.) is a rare inherited disease which occurs in infants (and children) after weaning from breast milk. A.E. is a human inborn error of metabolism for which zinc reverses the clinical symptoms.[2]

Clinical Manifestations of Deficiency

1. Manifestations of A.E.

   Growth retardation
   Anemia
   Sexual immaturity
   Hepatosplenomegaly
   Decreased wound healing
   Decreased cellular immunity and granulocyte formation
   Alopecia
   Diarrhea

2. Other clinical manifestations

   Glucose intolerance
   Decreased taste and smell
   Diarrhea
   Iron deficiency anemia
   Impaired dark adaptation

3. Zinc therapy improves wound healing in patients with zinc deficiency. However, there is no conclusive evidence that zinc stimulates healing in an individual with adequate zinc nutriture.

Major Cause of Toxicity

Excessive self-medication. It should be noted that there is a low incidence of toxicity in humans. But, a major concern is that the lay press and advertising media may overplay the value of zinc, leading some people to overuse zinc supplements.

Clinical Manifestations of Toxicity

GI problems, including pancreatitis, hyperamylasemia, acute GI irritation, vomiting, and anorexia

Blood abnormalities, including copper and iron deficiency anemia, and thrombocytopenia

Transient flushing and sweating, blurred vision, hypotension, pulmonary edema, and renal failure

Nutrient/Drug Interactions

1. Thiazides increase urinary excretion of zinc.
2. Alcohol decreases absorption of zinc.
3. Copper will inhibit zinc absorption.

Questions and Answers

Q. Should I advise patients to take zinc supplements?

A. It is not wise to use zinc supplements unless there is a medical reason for doing so. Persons on vegetarian or low animal protein diets may need zinc supplementation.

Q. Will zinc heal leg ulcers and decrease varicose veins?

A. The evidence thus far is questionable and inconclusive.

Q. What is the relationship of zinc to vitamin A metabolism in the patient with liver disease?

A. Evidence for zinc and vitamin A interaction is somewhat conflicting, but the need for zinc in the mobilization of liver vitamin A stores and in the ultilization of vitamin A in vision is reasonably well established. Patients with cirrhosis are not able to metabolize the vitamin A needed for dark adaptation, and zinc is excreted in large quantities in the urine. It is important to be aware of the loss of these nutrients in the treatment of liver disease.[3]

Q. Is hair analysis a good test for zinc status?

A. The most practical way to measure zinc status is to measure zinc levels in plasma or serum samples. When individuals are ill or have serious deficiencies in several nutrients, the hair growth rate decreases. Hair zinc levels have not been found to correlate with plasma zinc levels.[4]

Related Topics Concerning Vitamins and Trace Minerals

Hair Analysis

Hair analysis is not a valuable method for assessing the nutritional status of individuals. Many factors affect the interpretation of hair analysis, such as age, sex, hair treatments, and air pollution.

Advertising for hair analysis to determine nutritional deficiencies is receiving a great deal of attention in the lay press. If a clipping of hair is sent to a commercial laboratory for analysis, a report is sent to the client prescribing vitamins and minerals that one should take. Because vitamins are found only in the roots of hair below the skin, a clipping of hair will not give a reliable vitamin analysis.[1]

Hair analysis for heavy metals may be somewhat useful. There appears to be usefulness in forensic medicine as a screening device in comparing different populations' exposures to heavy metals. It may be possible, using hair analysis, to estimate the body content of lead, arsenic, mercury, and other heavy metals in populations suspected of metal intoxication.

The practices of hair analysis laboratories that prescribe nutritional therapy are most disturbing. Overall, hair analysis is of little value in determining vitamin or mineral status or the need for supplementation. Techniques for analyzing the hair for nutritional status are not yet perfected. Much research is needed before hair analysis may (if ever) be a worthwhile diagnostic test.[2]

Megavitamins

Those who take large doses of vitamins and trace minerals may be contributing to medical problems rather than solutions. Although megavitamin therapy poses a risk of toxicity, large doses of nutrients may correct or alleviate problems associated with malabsorption syndromes and some inborn errors of metabolism.

Table 23-3 Metabolic Derangements Successfully Treated With Megadoses of Vitamins*

Disorder	Dose
Pyridoxine	
Pyridoxine dependency (an enzymatic defect)	100 to 200 mg
Infantile convulsive disorders	10 to 50 mg
Sideroblastic anemia	10 mg or more
Urinary oxalate stones	100 to 500 mg
Homocystinuria	25 to 500 mg
Cystathioninuria	100 to 500 mg
Folic acid	
Congenital megaloblastic anemia	0.1 mg or more
Homocystinuria and homothioniuria	10.0 mg or more
Formimino transferase deficiency	5.0 mg or more
Malabsorption with megaloblastic anemia	0.05 mg
Vitamin B_{12}	
Juvenile pernicious anemia	5.0 μg or less
Transcobalamin II deficiency	100 μg or more
Methylmalonic aciduria	250 μg or more
Homocystinuria, hypomethioninemia	500 μg or more
Deficiency of essential fatty acids and fat-soluble vitamins in fat malabsorption syndromes	
Vitamin A	5,000 to 10,000 I.U.
Vitamin D	1,000 I.U. (adjusted)
Vitamin E	1 mg per kg
Vitamin K	1 mg water-soluble menadione

*This table lists some of the metabolic derangements that have been reported to respond to megadoses of certain vitamins. These are unusual syndromes. Favorable responses do not indicate that normal people would benefit in any way from large doses of these vitamins.

From Hodges, R.E.: "Megavitamin Therapy." *Primary Care.* 9:605-619, 1982, p.616. Used with permission of the publisher.

Malabsorption syndrome patients will benefit from vitamin therapy in the amounts suggested by Hodges in Table 23-3.[1] The amounts are generally well tolerated, at least for a few weeks. Care should be exercised in the administration of the doses of vitamins A and D for a prolonged period of time. You should ask patients at routine office visits if they are taking vitamin supplements on their own and, if so, how frequently and of what strength. Compare the dose with the RDAs and stay within 5 times that recommended amount.

The elderly are particularly prone to food misinformation and often take large amounts of vitamins and minerals to "ward off" or "cure" chronic diseases. If toxic symptoms should appear from excessive intake, immediate withdrawal of the offending vitamin is necessary, with the exception of vitamin C, which should be tapered over at least a three-day period. Large doses of vitamin C cause an increase in degradation of this vitamin. This process continues when massive doses are decreased, and a transient case of scurvy may result if tapering occurs faster than 3 days.

The same problem can occur in the newborn infant of a mother who has taken megadoses of vitamin C, thus creating a dangerous situation for the infant.

Orthomolecular psychiatry, promulgated initially by Hoffer and Osmund in the 1950s, involves the use of megavitamin C therapy (ascorbic acid plus B_6, B_{12}, and niacin) as an adjunct to conventional therapy in the treatment of schizophrenia. A task force of the American Psychiatric Association reviewed the uses of megavitamins and rejected the therapy. The proponents did not conduct controlled experiments or report their results satisfactorily. Massive doses of these vitamins can produce liver disease, and other toxic conditions, and may reverse the effects of some medications useful in the management of psychiatric illnesses.

Megavitamins are now being claimed to enhance the functioning of the immune system. Many studies have been undertaken to test these claims and are controversial.

Megavitamins are claimed to enhance the functioning of the immune system. Many studies have been undertaken to test these claims and animal studies have shown that megavitamins at extremely high levels enhance the immune system. Comparable doses in humans would produce toxic effects. A few attempts have also been made to study this relationship in the elderly. The aging process has long been associated with a progressive change in immune competence. The efficacy of vitamin and mineral supplementation in the elderly and its effect on immune function have yet to be substantiated.

There are a great many questions to be answered pertaining to nutrition and immunity in general, apart from those related specifically to meganutrient supplementation and the immune response in the elderly. Most long-term meganutrient therapy is not safe. Limits should be placed on megadoses until safe levels are established through further clinical and animal studies.

In summary, Hodges states:

> Megavitamin therapy arose from a natural inclination for people to believe that "if a little bit is good, a lot may be better." In the vast majority of instances, this philosophy has misled physicians and lay persons alike into a useless and sometimes dangerous form of therapy. On the other hand, there are some in which megadoses of a vitamin may accomplish a desired purpose. In any event, self-medication by lay persons is always unwise and may, in extreme situations, lead to serious injury or death.[1]

Non-Vitamins

There are many substances sold in health food stores which are claimed to be vitamins or "miracle drugs." Some substances may appear to have vitamin-like activity in microorganisms or animals but are not essential nutrients for man.

In order for a nutrient to be classified as a vitamin for humans it must meet one or more of the following criteria:

1. must have an essential biological role based on present knowledge;
2. the human cannot synthesize it at all or cannot synthesize it in sufficient amounts to meet metabolic needs; or

3. a deficiency disease results when it is omitted from the diet, and the deficiency is corrected only with its replacement in the diet.

Examples of Non-Vitamins

B_{15} (pangamic acid) and B_{17} (laetrile) are two non-vitamins that have received a great deal of recent attention in the media. Herbert[1] writes that pangamic acid has no nutritional worth, no vitamin properties, and may be harmful because of dangerous chemicals it may contain, such as dichloracetate or dimethylglycine. Since there is no standard of identity, the chemical composition of pangamic acid varies from year to year. No evidence of its safety as a food additive has been offered nor has it been approved by the Food and Drug Administration.

Laetrile (sold as vitamin B_{17}, but it is not a vitamin) has been widely advertised as a treatment for cancer. This dangerous substance is a cyanogenic glycoside. It is found in the seeds or pits of fruits such as peaches, plums, and apricots. When laetrile is digested in the intestines, it breaks down to cyanide, a lethal substance.[2]

Moertel[3] of the Mayo Clinic's Cancer Center treated 178 patients with laetrile, plus a program consisting of diet, enzymes, and vitamins. All subjects were patients with cancer who were still in generally good health. One-third had not received any previous chemotherapy. Laetrile did not cure, or lessen, any of the cancer-related symptoms.

A new product, superoxide dismutase (SOD), is the new "wonder" supplement which some claim can delay aging and enhance physical beauty. SOD functions as a free-radical superoxide scavenger, an important process for maintenance of cellular integrity. The "catch" here is that the enzyme is a protein and is digested and cannot be absorbed intact.[4]

Choline is not a vitamin since it can be synthesized in the body. There is little evidence that choline will improve the failing memory of older persons, and it has not been shown to be associated with a specific deficiency disease in man. Choline may play a role in preventing fatty livers in experimental animals.

Para-aminobenzoic Acid (PABA) is a growth factor for bacteria. Although it is an anti-grey-hair factor in black rats and mice, it is not effective in man. PABA inhibits the effectiveness of sulfa drugs, and may actually stimulate the growth of certain microorganisms. Patients taking antibiotics should be advised against the concomitant use of PABA.

Inositol has not been determined to be a vitamin for man. In plants, inositol is found as phytic acid, which interferes with absorption of calcium and iron. It was initially called a vitamin because of its anti-hair-loss effects in mice.[5] The application or ingestion of inositol is not known to prevent the loss or thinning of hair in humans.

Coenzyme Q (Ubiquinone) is a constituent of phospholipids of the mitochondrial membrane. It can be synthesized in the cell and is therefore not a true vitamin.

Bioflavinoids ("vitamin" P) is extracted from lemon peels and red peppers. The substance citrin has been found to be biologically active in maintaining normal capillary fragility in animals suffering from scurvy. Use of this product is of no value in prevention or treatment of colds. The vitamin C-like effect of bioflavinoids appears to be due to an antioxidant effect which protects ascorbic acid from oxidative destruction.[6]

Carnitine participates in the transfer of long-chain fatty acids into the mitochondrial membrane for oxidation and initiation of beta-oxidation. Carnitine was first considered to be a vitamin and was named vitamin B_t. However, it is not a dietary essential (it can be synthesized from lysine and methionine) and has no rational use as a supplement for adult humans. Attention is currently being given to the role of carnitine in malnourished patients, infants receiving commercial infant formulas, and in patients receiving long-term TPN.[7]

Summary

As part of the food intake history for every patient, it is important to know if supplemental vitamins and trace minerals are being taken and why. Ingestion of amounts greater than five to ten times the Recommended Dietary Allowances on a daily basis can be toxic and dangerous, and such practices should be discouraged. Malabsorption syndromes and some inborn errors of metabolism may, however, be corrected or alleviated by large doses of specific nutrients.

If a patient is taking over-the-counter vitamin and trace mineral supplements that contain nutrients equal to the RDAs, it should be emphasized that supplements do not correct poor dietary habits. A variety of foods

selected from the basic food groups will supply nutrients in adequate amounts for most people. If it is necessary to use a supplement, suggest 1-2 tablets daily of generic brand supplements equal to the RDAs. Natural and synthetic vitamins and minerals have the same potency.

It is important to evaluate and be wary of exaggerated claims made for rare vitamins and/or nutritional substances extolled by health food stores and in lay magazines. More research is needed to substantiate these claims before recommending nutritional products.

Table 23-4 (Reference for Patients) Recommended Food Intake for Good Nutrition According to Food Groups and the Average Size of Servings at Different Age Levels

Food Group	Servings per Day	Average Size of Servings					
		1 year	*2–3 years*	*4–5 years*	*6–9 years*	*10–12 years*	*13–15 years*
Milk and cheese (1.5 oz cheese = 1 C milk)	4	½ C*	½–¾ C	½–¾ C	½–1 C	½–1 C	½–1 C
Meat group (protein foods)	3 or more						
Egg		1	1	1	1	1	1 or more
Lean meat, fish, poultry (liver once a week)		2 Tbsp†	2 Tbsp	4 Tbsp	2–3 oz (4–6 Tbsp)	3–4 oz	4 oz or more
Peanut butter			1 Tbsp	2 Tbsp	2–3 Tbsp	3 Tbsp	3 Tbsp
Fruits and vegetables							
Vitamin C source (citrus fruits, berries, tomato, cabbage, cantaloupe)	At least 4, including: 1 or more (twice as much tomato as citrus)	⅓ C (citrus)	½ C	½ C	1 medium orange	1 medium orange	1 medium orange
Vitamin A source (green or yellow fruits and vegetables)	1 or more	2 Tbsp	3 Tbsp	4 Tbsp (¼ C)	¼ C	⅓ C	½ C
Other vegetables (potato and legumes, etc.) *or*	2	2 Tbsp	3 Tbsp	4 Tbsp (¼ C)	⅓ C	½ C	¾ C
Other fruits (apple, banana, etc.)		¼ C	⅓ C	½ C	1 medium	1 medium	1 medium
Cereals (whole-grain or enriched)	At least 4						
Bread		½ slice	1 slice	1½ slices	1–2 slices	2 slices	2 slices
Ready-to-eat cereals		½ oz	¾ oz	1 oz	1 oz	1 oz	1 oz
Cooked cereal (including macaroni, spaghetti, rice, etc.)		¼ C	⅓ C	½ C	½ C	¾ C	1 C or more
Fats and carbohydrates	To meet caloric needs						
Butter, margarine, mayonnaise, oils: 1 Tbsp = 100 calories (kcal)		1 Tbsp	1 Tbsp	1 Tbsp	2 Tbsp	2 Tbsp	2–4 Tbsp
Desserts and sweets: 100-calorie portions as follows: ⅓ C pudding or ice cream, 2 3" cookies, 1 oz cake, 1⅓ oz pie, 2 tbsp jelly, jam, honey, sugar		1 portion	1½ portions	1½ portions	3 portions	3 portions	3–6 portions

*C = 1 cup or 8 oz or 240 ml.
†Tbsp = Tablespoon (1 Tbsp = ca. 15 ml = ca. ½ oz).
Modified with Mildred J. Bennett, Ph.D., from "Four Food Groups of the Daily Food Guide," Institute of Home Economics, U.S.D.A., and Publication #30, Children's Bureau of the United States Department of Health, Education, and Welfare.

From "Nutrition and Nutritional Disorders," in *Nelson's Textbook of Pediatrics*, 12th ed. Behrman, R.E., Vaughn, V.C., and Nelson, W.E. (eds.). Philadelphia: W.B. Saunders Co., 1983, p.147. Used with permission of the publisher.

Evaluation

The following evaluation is intended to serve as a guide to assist you in reviewing the material contained in this module. Please complete the activity and then discuss the activity with other residents, faculty, and, if available, a nutrition specialist.

A 38-year-old white female presents herself for a routine check-up and yearly pap smear. Because of your newfound understanding of the importance of vitamins and trace minerals, you decide to include some nutrition-related questions in your evaluation (see table 23-2). You find out that your patient

seldom drinks milk and does not like most milk products;

eats a large amount of fruit, especially grapefruit, as part of a diet she is trying;

views herself as overweight (actually less than 5% above average weight for her height, age, and sex);

avoids starchy foods, red meats, fatty foods, and salt; and

occasionally binges on sweets.

1. What further questions should you ask this patient?
2. Given what little information you have, what deficiencies (or excesses) in vitamins and minerals might this person be experiencing?
3. Upon further questioning, you find that your patient takes megadoses of vitamins A, C, E, and B_{12}. What possible side effects should you look for?
4. What counsel would you give your patient with regard to her

   "grapefruit diet?"

   disdain for milk and milk products?

   megadose-usage of vitamins?

   perceived need to diet?

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Appendix A

Food and Nutrition Board, National Academy of Sciences-National Research Council
RECOMMENDED DAILY DIETARY ALLOWANCES,[a] Revised 1980
Designed for the maintenance of good nutrition of practically all healthy people in the U.S.A.

							Fat-Soluble Vitamins			Water-Soluble Vitamins							Minerals					
	Age (years)	Weight (kg)	Weight (lbs)	Height (cm)	Height (in)	Protein (g)	Vitamin A (µg R.E.)[b]	Vitamin D (µg)[c]	Vitamin E (mg α T.E.)[d]	Vitamin C (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg N.E.)[e]	Vitamin B6 (mg)	Folacin[f] (µg)	Vitamin B12 (µg)	Calcium (mg)	Phosphorus (mg)	Magnesium (mg)	Iron (mg)	Zinc (mg)	Iodine (µg)
Infants	0.0-0.5	6	13	60	24	kg x 2.2	420	10	3	35	0.3	0.4	6	0.3	30	0.5[g]	360	240	50	10	3	40
	0.5-1.0	9	20	71	28	kg x 2.0	400	10	4	35	0.5	0.6	8	0.6	45	1.5	540	360	70	15	5	50
Children	1-3	13	29	90	35	23	400	10	5	45	0.7	0.8	9	0.9	100	2.0	800	800	150	15	10	70
	4-6	20	44	112	44	30	500	10	6	45	0.9	1.0	11	1.3	200	2.5	800	800	200	10	10	90
	7-10	28	62	132	52	34	700	10	7	45	1.2	1.4	16	1.6	300	3.0	800	800	250	10	10	120
Males	11-14	45	99	157	62	45	1000	10	8	50	1.4	1.6	18	1.8	400	3.0	1200	1200	350	18	15	150
	15-18	66	145	176	69	56	1000	10	10	60	1.4	1.7	18	2.0	400	3.0	1200	1200	400	18	15	150
	19-22	70	154	177	70	56	1000	7.5	10	60	1.5	1.7	19	2.2	400	3.0	800	800	350	10	15	150
	23-50	70	154	178	70	56	1000	5	10	60	1.4	1.6	18	2.2	400	3.0	800	800	350	10	15	150
	51+	70	154	178	70	56	1000	5	10	60	1.2	1.4	16	2.2	400	3.0	800	800	350	10	15	150
Females	11-14	46	101	157	62	46	800	10	8	50	1.1	1.3	15	1.8	400	3.0	1200	1200	300	18	15	150
	15-18	55	120	163	64	46	800	10	8	60	1.1	1.3	14	2.0	400	3.0	1200	1200	300	18	15	150
	19-22	55	120	163	64	44	800	7.5	8	60	1.1	1.3	14	2.0	400	3.0	800	800	300	18	15	150
	23-50	55	120	163	64	44	800	5	8	60	1.0	1.2	13	2.0	400	3.0	800	800	300	18	15	150
	51+	55	120	163	64	44	800	5	8	60	1.0	1.2	13	2.0	400	3.0	800	800	300	10	15	150
Pregnant						+30	+200	+5	+2	+20	+0.4	+0.3	+2	+0.6	+400	+1.0	+400	+400	+150	*h*	+5	+25
Lactating						+20	+400	+5	+3	+40	+0.5	+0.5	+5	+0.5	+100	+1.0	+400	+400	+150	*h*	+10	+50

a The allowances are intended to provide for individual variations among most normal persons as they live in the United States under usual environmental stresses. Diets should be based on a variety of common foods in order to provide other nutrients for which human requirements have been less well defined. See text for detailed discussion of allowances and of nutrients not tabulated. See Table III (p. 4) for weights and heights by individual year of age. See Table III (p. 4) for suggested average energy intakes.

b Retinol equivalents. 1 retinol equivalent = 1 µg retinol or 6 µg β-carotene. See text for calculation of vitamin A activity of diets as retinol equivalents.

cholecalciferol. 10 µg cholecalciferol = 400 I.U. vitamin D.

d α-tocopherol equivalents. 1 mg d-α-tocopherol = 1 α T.E. See text for variation in allowances and calculation of vitamin E activity of the diet as α-tocopherol equivalents.

e 1 N.E. (niacin equivalent) is equal to 1 mg of niacin or 60 mg of dietary tryptophan.

f The folacin allowances refer to dietary sources as determined by *Lactobacillus casei* assay after treatment with enzymes ("conjugases") to make polyglutamyl forms of the vitamin available to the test organism.

g The RDA for vitamin B12 in infants is based on average concentration of the vitamin in human milk. The allowances after weaning are based on energy intake (as recommended by the American Academy of Pediatrics) and consideration of other factors such as intestinal absorption; see text.

h The increased requirement during pregnancy cannot be met by the iron content of habitual American diets nor by the existing iron stores of many women; therefore the use of 30 - 60 mg of supplemental iron is recommended. Iron needs during lactation are not substantially different from those of nonpregnant women, but continued supplementation of the mother for 2 - 3 months after parturition is advisable in order to replenish stores depleted by pregnancy.

From Food and Nutrition Board, National Academy of Sciences—National Research Council: *Recommended Dietary Allowances*, 9th edition, Washington, D.C.: National Academy Press, 1980. Used with permission of the publisher.

Appendix B

Estimated Safe and Adequate Daily Dietary Intakes of Additional Selected Vitamins and Minerals[a]

Vitamins

	Age (years)	Vitamin K (μg)	Biotin (μg)	Pantothenic Acid (mg)
Infants	0–0.5	12	35	2
	0.5–1	10–20	50	3
Children	1–3	15–30	65	3
and	4–6	20–40	85	3–4
Adolescents	7–10	30–60	120	4–5
	11+	50–100	100–200	4–7
Adults		70–140	100–200	4–7

Trace Elements[b]

	Age (years)	Copper (mg)	Manganese (mg)	Fluoride (mg)	Chromium (mg)	Selenium (mg)	Molybdenum (mg)
Infants	0–0.5	0.5–0.7	0.5–0.7	0.1–0.5	0.01–0.04	0.01–0.04	0.03–0.06
	0.5–1	0.7–1.0	0.7–1.0	0.2–1.0	0.02–0.06	0.02–0.06	0.04–0.08
Children	1–3	1.0–1.5	1.0–1.5	0.5–1.5	0.02–0.08	0.02–0.08	0.05–0.1
and	4–6	1.5–2.0	1.5–2.0	1.0–2.5	0.03–0.12	0.03–0.12	0.06–0.15
Adolescents	7–10	2.0–2.5	2.0–3.0	1.5–2.5	0.05–0.2	0.05–0.2	0.10–0.3
	11+	2.0–3.0	2.5–5.0	1.5–2.5	0.05–0.2	0.05–0.2	0.15–0.5
Adults		2.0–3.0	2.5–5.0	1.5–4.0	0.05–0.2	0.05–0.2	0.15–0.5

Electrolytes

	Age (years)	Sodium (mg)	Potassium (mg)	Chloride (mg)
Infants	0–0.5	115–350	350–925	275–700
	0.5–1	250–750	425–1275	400–1200
Children	1–3	325–975	550–1650	500–1500
and	4–6	450–1350	775–2325	700–2100
Adolescents	7–10	600–1800	1000–3000	925–2775
	11+	900–2700	1525–4575	1400–4200
Adults		1100–3300	1875–5625	1700–5100

[a] Because there is less information on which to base allowances, these figures are not given in the main table of the RDA and are provided here in the form of ranges of recommended intakes.
[b] Since the toxic levels for many trace elements may be only several times usual intakes, the upper levels for the trace elements given in this table should not be habitually exceeded.

From Food and Nutrition Board, National Academy of Sciences—National Research Council: *Recommended Dietary Allowances*, 9th edition. Washington, D.C.: National Academy Press, 1980. Used with permission of the publisher.

Appendix C

Clinical nutrition examination

Clinical findings	Consider deficiency of	Consider excess of
Hair, nails		
Flag sign (transverse discolored band of hair)	Protein, copper	
Hair easily pluckable	Protein	
Hair thin, sparse	Protein, biotin, zinc	Vitamin A
Nails spoon-shaped	Iron	
Nails brittle/ridged, transverse edging	Protein-calorie	
Skin		
Dry, scaling	Vitamin A, zinc, essential fatty acids	Vitamin A
Erythematous eruption (sunburn-like)		Vitamin A
Flaky paint dermatosis	Protein	
Follicular hyperkeratosis	Vitamins A, C, essential fatty acids	
Nasolabial seborrhea	Niacin, pyridoxine, riboflavin	
Petechiae, purpura	Ascorbic acid, vitamin K	
Pigmentation, desquamation (sun-exposed areas)	Niacin (pellagra)	
Subcutaneous fat loss	Calorie	
Yellow pigmentation spanning sclerae (benign)		Carotene
Eyes		
Angular palpebritis	Riboflavin	
Band keratitis		Vitamin D
Corneal vascularization	Riboflavin	
Dull, dry conjunctiva	Vitamin A	
Fundal capillary microaneurysms	Ascorbic acid	
Papilledema		Vitamin A
Scleral icterus, mild	Pyridoxine	
Perioral		
Angular stomatitis	Riboflavin	
Cheilosis	Riboflavin	
Oral		
Atrophic lingual papillae	Niacin, iron, riboflavin, folate, vitamin B_{12}	
Glossitis (scarlet, raw)	Niacin, pyridoxine, riboflavin, vitamin B_{12}, folate	
Hypogeusesthesia (also hyposmia)	Zinc, vitamin A	
Magenta tongue	Riboflavin	
Swollen, bleeding gums (if teeth present)	Ascorbic acid	
Tongue fissuring, edema	Niacin	

Clinical findings	Consider deficiency of	Consider excess of
Glands		
Parotid enlargement	Protein	
"Sicca" syndrome	Ascorbic acid	
Thyroid enlargement	Iodine	
Heart		
Enlargement, tachycardia, high output failure	Thiamine ("wet" beriberi)	
Small heart, decreased output	Calorie	
Sudden failure, death	Ascorbic acid	
Abdomen		
Hepatomegaly	Protein	Vitamin A
Muscles, extremities		
Calf tenderness	Thiamine, ascorbic acid (hemorrhage into muscle)	
Edema	Protein, thiamine	
Muscle wastage (especially temporal area, dorsum of hand, spine)	Calorie	
Bones, joints		
Beading of ribs (child)	Vitamins C, D	
Bone and joint tenderness (child)	Ascorbic acid (subperiosteal hemorrhage)	Vitamin A
Bone tenderness (adult)	Vitamin D, calcium, phosphorus (osteomalacia)	
Bulging fontanelle (child)		Vitamin A
Craniotabes, bossing (child)		Vitamin D
Neurologic		
Confabulation, disorientation	Thiamine (Korsakoff's psychosis)	
Decreased position and vibratory sense, ataxia	Vitamin B_{12}, thiamine	
Decreased tendon reflexes, slowed relaxation phase	Thiamine	
Drowsiness, lethargy		Vitamins A, D
Ophthalmoplegia	Thiamine, phosphorus	
Weakness, paresthesias, decreased fine tactile sensation	Vitamin B_{12}, pyridoxine, thiamine	
Other		
Delayed healing and tissue repair (e.g., wound, infarct, abscess)	Ascorbic acid, zinc, protein	
Fever (low-grade)		Vitamin A

From Weinsier, R.L., and Butterworth, C.D.: *Handbook of Clinical Nutrition*. St. Louis, MO: C.V. Mosby Co., 1981, pp. 30-31. Used with permission of the publisher.

Appendix D

Interpretation of Laboratory Tests for the Evaluation of Nutritional Status (Adults)

Nutrient evaluation	Test	Deficient (often with clinical manifestations)	Low (usually without clinical manifestations)	Acceptable
Protein	Serum albumin, g/dl	<3.0	3.0-3.5	>3.5
Protein	Serum transferrin, mg/dl (Cr-Sr)	<180-200		180-200
Protein	Serum prealbumin, mg/dl	<20-50		20-50
Protein	Serum retinol binding protein, µg/ml	<30-45		30-45
Protein	Creatinine height ratio	<90% of Standard	90-95%	>95%
Protein	Nitrogen balance, g	>+3	(+1)-3	0-3
Protein, Fe, folacin, vitamin B_{12}	Hemoglobin, g/dl	<12	12-14	>14
Iron	Serum iron, µg/dl	<60		>60
Vitamin A	Plasma retinol, µg/dl	<10	10-20	>20
Vitamin D	Serum Ca × P product, mg/dl	<40		>40
Vitamin D	Alkaline phosphatase, King-Armstrong units/dl	>40	15-40	8-14
Vitamin C	Serum ascorbic acid, mg/dl	<0.20	0.20-0.30	>0.30
Thiamin	Erythrocyte transketolase (% thiamin disphosphate stimulation)	>20	15-20	<15
Riboflavin	Erythrocyte glutathione reductase activity coefficient	>1.40	1.20-1.40	<1.20
Niacin	N-Methylnicotinamide excretion, mg/g creatinine	<0.5	0.5-1.59	>1.6
Vitamin B_6	Erythrocyte aminotransferase activity coefficients:			
	EGPT	>1.25		<1.25
	EGOT	>1.5		<1.5
Vitamin B_6	Tryptophan load test (xanthurenic acid), mg/day	>50	25-50	<25
Folacin	Serum folate, ng/ml	<3	3.0-6.0	>6.0
Folacin	Erthrocyte folate, ng/ml	<140	140-160	>160
Vitamin B_{12}	Serum vitamin B_{12}, pg/ml	<150	150-200	>200
Ca	24-h urine Ca^{2+}, mg	<50	50-100	>100
P	24-h urine P, mg	<100	100-300	>300
Mg	24-h urine Mg^{2+}, meq	<4	4-8	>8
Na	24-h urine Na^{+}, meq	<20	20-40	>40
K	24-h urine K^{+}, meq	<20	20-40	>40

From VanItalle, T.B.: "Assessment of Nutritional Status," in Harrison's Principles of Internal Medicine, 10th edition. Wintrobe, M.M., et al. (eds.). New York: McGraw-Hill, 1983, p. 435. Used with permission of the publisher.

Appendix E

Plasma and Urine Nutrient Levels of Vitamins Indicative of Inadequate Intake, Malabsorption, or Increased Requirement

Plasma[a]		Urine (all values/g urinary creatinine)[a]	
albumin	3.5 gm/100 ml	iodine	50 µg
iron	70 µg/100 ml	N-methylnicotinamide	1.6 mg
retinol	20 µg/100 ml	riboflavin	80 µg
carotene	80 µg/100 ml	thiamin	66 µg
ascorbic acid	300 µg/100 ml	in children under six years[b]	
vitamin B_{12}	70 pg/ml	riboflavin	300 µg
folic acid	7 ng/ml	thiamin	120 µg

[a]Values at or below these levels suggest nutrient deficiency and the need for dietary supplements or treatment.
[b]In addition, a serum alkaline phosphatase level in a child above 4 Bodansky (25 King-Armstrong) units suggests subclinical vitamin D deficiency. Higher values are, however, not infrequently found in children with no radiographic evidence of rickets.

From Sandstead, H.H., Carter, J.P., and Darby, W.J.: "How to diagnose Nutritional Deficiencies in Daily Practice." *Nutrition Today*, 4(2): 20-26, 1969, p. 26. Used with permission of the publisher.

Guide to Good Eating

Milk Group

Calcium
Riboflavin (B_2)
Protein

2 Servings/Adults
4 Servings/Teenagers
3 Servings/Children

Foods made from milk contribute part of the nutrients supplied by a serving of milk.

Meat Group

Protein
Niacin
Iron
Thiamin (B_1)

2 Servings

Dry beans and peas, soy extenders, and nuts combined with animal protein (meat, fish, poultry, eggs, milk, cheese) or grain protein can be substituted for a serving of meat.

Fruit-Vegetable Group

Vitamins A and C

4 Servings

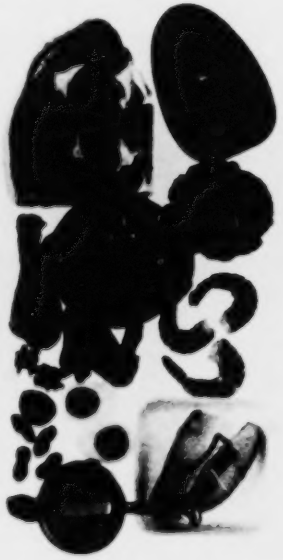
Dark green, leafy, or orange vegetables and fruit are recommended 3 or 4 times weekly for vitamin A. Citrus fruit is recommended daily for vitamin C.

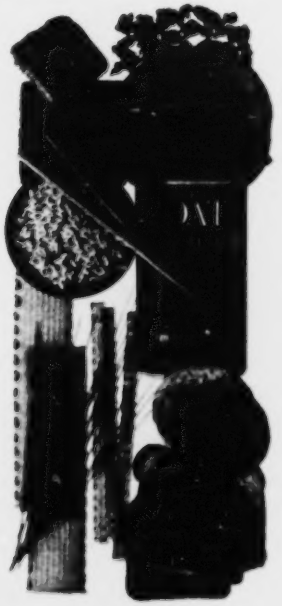
Grain Group

Carbohydrate
Thiamin (B_1)
Iron
Niacin

4 Servings

Whole grain, fortified, or enriched grain products are recommended.





Foods and condiments such as these compliment but do not replace foods from the four groups.

Amounts should be determined by individual caloric needs.

Others

Carbohydrate
Fats

Guide to Good Eating

A Recommended Daily Pattern

Guide to Good Eating...

A Recommended Daily Pattern

The recommended daily pattern provides the foundation for a nutritious, healthful diet.

The recommended servings from the Four Food Groups for adults supply about 1200 Calories. The chart below gives recommendations for the number and size of servings for several categories of people.

Food Group	Recommended Number of Servings				
	Child	Teenager	Adult	Pregnant Woman	Lactating Woman
Milk 1 cup milk, yogurt, OR **Calcium Equivalent** 1½ slices (1½ oz) cheddar cheese* 1 cup pudding 1½ cups ice cream 2 cups cottage cheese*	3	4	2	4	4
Meat 2 ounces cooked, lean meat, fish, poultry, OR **Protein Equivalent** 2 eggs 2 slices (2 oz) cheddar cheese* ½ cup cottage cheese* 1 cup dried beans, peas 4 tbsp peanut butter	2	2	2	3	2
Fruit-Vegetable ½ cup cooked or juice 1 cup raw Portion commonly served such as a medium-size apple or banana	4	4	4	4	4
Grain, whole grain, fortified, enriched 1 slice bread 1 cup ready-to-eat cereal ½ cup cooked cereal, pasta, grits	4	4	4	4	4

*Count cheese as serving of milk OR meat, not both simultaneously.

*Others: complement but do not replace foods from the Four Food Groups. Amounts should be determined by individual caloric needs.

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Nutrients for Health

Nutrients are chemical substances obtained from foods during digestion. They are needed to build and maintain body cells, regulate body processes, and supply energy.

About 50 nutrients, including water, are needed daily for optimum health. If one obtains the proper amount of the 10 "leader" nutrients in the daily diet, the other 40 or so nutrients will likely be consumed in amounts sufficient to meet body needs.

One's diet should include a variety of foods because no single food supplies all the 50 nutrients, and because many nutrients work together.

When a nutrient is added or a nutritional claim is made, nutrition labeling regulations require listing the 10 leader nutrients on food packages. These nutrients appear in the chart below with food sources and some major physiological functions.

Nutrient	Important Sources of Nutrient	Some major physiological functions		
		Provide energy	Build and maintain body cells	Regulate body processes
Protein	Meat, Poultry, Fish Dried Beans and Peas Egg Cheese Milk	Supplies 4 Calories per gram.	Constitutes part of the structure of every cell, such as muscle, blood, and bone; supports growth and maintains healthy body cells.	Constitutes part of enzymes, some hormones and body fluids, and antibodies that increase resistance to infection.
Carbohydrate	Cereal Potatoes Dried Beans Corn Bread Sugar	Supplies 4 Calories per gram. Major source of energy for central nervous system.	Supplies energy so protein can be used for growth and maintenance of body cells.	Unrefined products supply fiber – complex carbohydrates in fruits, vegetables, and whole grains – for regular elimination. Assists in fat utilization.
Fat	Shortening, Oil Butter, Margarine Salad Dressing Sausages	Supplies 9 Calories per gram.	Constitutes part of the structure of every cell. Supplies essential fatty acids.	Provides and carries fat-soluble vitamins (A, D, E, and K).
Vitamin A (Retinol)	Liver Carrots Sweet Potatoes Greens Butter, Margarine		Assists formation and maintenance of skin and mucous membranes that line body cavities and tracts, such as nasal passages and intestinal tract, thus increasing resistance to infection.	Functions in visual processes and forms visual purple, thus promoting healthy eye tissues and eye adaptation in dim light.
Vitamin C (Ascorbic Acid)	Broccoli Orange Grapefruit Papaya Mango Strawberries		Forms cementing substances, such as collagen, that hold body cells together, thus strengthening blood vessels, hastening healing of wounds and bones, and increasing resistance to infection.	Aids utilization of iron.
Thiamin (B_1)	Lean Pork Nuts Fortified Cereal Products	Aids in utilization of energy.		Functions as part of a coenzyme to promote the utilization of carbohydrate. Promotes normal appetite. Contributes to normal functioning of nervous system.
Riboflavin (B_2)	Liver Milk Yogurt Cottage Cheese	Aids in utilization of energy.		Functions as part of a coenzyme in the production of energy within body cells. Promotes healthy skin, eyes, and clear vision.
Niacin	Liver Meat, Poultry, Fish Peanuts Fortified Cereal Products	Aids in utilization of energy.		Functions as part of a coenzyme in fat synthesis, tissue respiration, and utilization of carbohydrate. Promotes healthy skin, nerves, and digestive tract. Aids digestion and fosters normal appetite.
Calcium	Milk, Yogurt Cheese Sardines and Salmon with Bones Collard, Kale, Mustard, and Turnip Greens		Combines with other minerals within a protein framework to give structure and strength to bones and teeth.	Assists in blood clotting. Functions in normal muscle contraction and relaxation, and normal nerve transmission.
Iron	Enriched Farina Prune Juice Liver Dried Beans and Peas Red Meat	Aids in utilization of energy.	Combines with protein to form hemoglobin, the red substance in blood that carries oxygen to and carbon dioxide from the cells. Prevents nutritional anemia and its accompanying fatigue. Increases resistance to infection.	Functions as part of enzymes involved in tissue respiration.

From National Dairy Council: *A Guide to Good Eating*, 4th edition. Rosemont, Illinois, 1977. Used with permission of the National Dairy Council.

Appendix G

Food Composition Table for Short Method of Dietary Analysis (3rd Revision)

Food and Approximate Measure	Weight gm	Food Energy Cal.	Protein gm	Fat gm	Carbohydrate gm	Calcium mg	Iron, mg	Vitamin A Value IU	Thiamine mg	Riboflavin mg	Niacin mg	Ascorbic Acid mg
Milk, cheese, cream; related products												
Cheese; blue, cheddar (1 cu in., 17 gm), cheddar process (1 oz), Swiss (1 oz)	30	105	6	9	1	165	0.2	345	0.01	0.12	trace	0
cottage (from skim) creamed (½ cup)	115	120	16	5	3	105	0.4	190	0.04	0.28	0.1	0
Cream: half and half (cream and milk) (2 Tbsp)	30	40	1	4	2	30	trace	145	0.01	0.04	trace	trace
For light whipping add 1 pat butter	245	160	9	9	12	285	0.1	350	0.08	0.42	0.1	2
Milk; whole (3.5% fat) (1 cup)	245	90	9	trace	13	300	trace	---	0.10	0.44	0.2	2
fluid, nonfat (skim) and buttermilk (from skim)												
milk beverages, (1 c) cocoa, chocolate drink made with skim milk. For malted milk add 4 tbsp half and half (270 gm)	245	210	8	8	26	280	0.6	300	0.09	0.43	0.3	trace
milk desserts, custard (1 c) 248 gm ice cream (8 fl oz) 142 gm		290	8	17	29	210	0.4	785	0.07	0.34	0.1	1
cornstarch pudding (248 gm) ice milk (1 c) 187 gm		280	9	10	40	290	0.1	390	0.08	0.41	0.3	2
White sauce, med (1/2 c)	130	215	5	16	12	150	0.2	610	0.06	0.22	0.3	trace
Egg; 1 large	50	80	6	6	trace	25	1.2	590	0.06	0.15	trace	0
Meat, poultry fish, shellfish, related products												
Beef, lamb, veal; lean and fat, cooked inc. corned beef (3 oz) (all cuts)	85	245	22	16	0	10	2.9	25	0.06	0.19	4.2	0
lean only, cooked; dried beef (2+ oz) (all cuts)	65	140	20	5	0	10	2.4	10	0.05	0.16	3.4	0
Beef, relatively fat, such as steak and rib, cooked (3oz)	85	350	18	30	0	10	2.4	60	0.05	0.14	3.5	0
Liver: beef, fried (2 oz)	55	130	15	6	3	5	5.0	30,280	0.15	2.37	9.4	15
Pork, lean & fat, cooked (3 oz) (all cuts)	85	325	20	24	0	10	2.6	0	0.62	0.20	4.2	0
lean only, cooked (2+ oz) (all cuts)	60	150	18	8	0	5	2.2	0	0.57	0.19	3.2	0
ham, light cure, lean & fat, roasted (3 oz)	85	245	18	19	0	10	2.2	0	0.40	0.16	3.1	0
Luncheon meats: bologna (2 sl), pork sausage cooked (2 oz), frankfurter (1), bacon, broiled or fried crisp (3 sl)		185	9	16	---	5	1.3	---	0.21	0.12	1.7	0
Poultry												
chicken; flesh only, broiled (3 oz)	85	115	20	3	0	10	1.4	80	0.05	0.16	7.4	0
fried (2+ oz)	75	170	24	6	1	10	1.6	85	0.05	0.23	8.3	0
turkey, light & dark, roasted (3 oz)	85	160	27	5	0	---	1.5	---	0.03	0.15	6.5	0

(continued)

Food and Approximate Measure	Weight gm	Food Energy Cal.	Protein gm	Fat gm	Carbohydrate gm	Calcium mg	Iron, mg	Vitamin A Value IU	Thiamine mg	Riboflavin mg	Niacin mg	Ascorbic Acid mg
Fish and shellfish												
salmon (3 oz) (canned)	85	130	17	5	0	165	0.7	60	0.03	0.16	6.8	0
fish sticks, breaded, cooked (3-4)	75	130	13	7	5	10	0.3	--	0.03	0.05	1.2	0
macherel, halibut, cooked	85	175	19	10	0	10	0.8	515	0.08	0.15	6.8	0
blue fish, haddock, herring, perch, shad, cooked (tuna canned in oil, 20 gm)	85	160	19	8	2	20	1.0	60	0.06	0.11	4.4	0
clams, canned; crab meat, canned; lobster, oyster, raw; scallop; shrimp, canned	85	75	14	1	2	65	2.5	65	0.10	0.08	1.5	0
Mature dry beans and peas, nuts, peanuts, related products												
Beans: white with pork and tomato, canned (1 c)	260	320	16	7	50	1[illegible]0	4.7	340	0.20	0.08	1.5	5
red (128 gm), Lima (96 gm), cowpeas (125 gm), cooked (½ c)		125	8	-	25	35	2.5	5	0.13	0.06	0.7	-
Nuts: almonds (12), cashews (8), peanuts (1 tbsp), peanut butter (1 tbsp), pecans (12), English walnuts (2 tbsp), coconut (¼ c)	15	95	3	8	4	15	0.5	5	0.05	0.04	0.9	-
Vegetables and Vegetable products												
Asparagus, cooked, cut spears (2/3 c)	115	25	3	trace	4	25	0.7	1,055	0.19	0.20	1.6	30
Beans: green(½ c), cooked 60 gm, canned 120 gm		15	1	trace	3	30	0.4	340	0.04	0.06	0.3	8
Lima, immature, cooked (½ c)	80	90	6	1	16	40	2.0	225	0.14	0.08	1.0	14
Broccoli spears, cooked (2/3 c)	100	25	3	trace	4	90	0.8	2,500	0.09	0.20	0.8	90
Brussels sprouts, cooked (2/3 c)	85	30	3	trace	5	30	1.0	450	0.07	0.12	0.7	75
Cabbage (110 gm), cauliflower, cooked (80 gm), and sauerkraut canned (150 gm) (reduce ascorbic acid value by one-third for kraut) (2/3 c)		20	1	trace	4	35	0.5	80	0.05	0.05	0.3	37
Carrots, cooked (2/3 c)	95	30	1	trace	7	30	0.6	10,145	0.05	0.05	0.5	6
Corn, 1 ear, cooked (140 gm), canned (130 gm) (½ c)		75	2	trace	18	5	0.4	315	0.06	0.06	1.1	6
Leafy greens, collards (125 gm), dandelions (120 gm) kale (75 gm), mustard (95 gm), spinach (120 gm), turnip (100 gm cooked, 150 gm canned) (2/3 c cooked and canned) (reduce ascorbic acid one-half for canned)		30	3	trace	5	175	1.8	8,570	0.11	0.18	0.8	45
Peas, green (½ c)	80	60	4	1	10	20	1.4	430	0.22	0.09	1.8	16
Potatoes-baked, boiled (100 gm), 10 pc French fried (55 gm) (for fried, add 1 tbsp cooking oil)		85	3	trace	30	10	0.7	trace	0.08	0.04	1.5	16

(continued)

Food and Approximate Measure	Weight gm	Food Energy Cal.	Protein gm	Fat gm	Carbohydrate gm	Calcium mg	Iron, mg	Vitamin A Value IU	Thiamine mg	Riboflavin mg	Niacin mg	Ascorbic Acid mg
Pumpkin, canned (½ c)	115	40	1	1	9	30	0.5	7,295	0.03	0.06	0.6	6
Squash, winter, canned (½ c)	100	65	2	1	16	30	0.8	4,305	0.05	0.14	0.7	14
Sweet potato, canned (1/2 c)	110	120	2	-	27	25	0.8	8,500	0.05	0.05	0.07	15
Tomato, 1 raw, 2/3 c canned, 2/3 c juice	150	35	2	trace	7	14	0.8	1,350	0.10	0.06	1.0	29
Tomato catsup (2 tbsp)	35	30	1	trace	8	10	0.2	480	0.04	0.02	0.6	6
Other cooked (beets, mushrooms, onions, turnips) (½ c)	95	25	1	-	5	20	0.5	15	0.02	0.10	0.7	7
Others commonly served raw, cabbage (½ c, 50 gm), celery (3 sm stalks, 40 gm), cucumber (½ med, 50 gm), green pepper (½, 30 gm), radishes (5, 40 gm)		10	trace	trace	2	15	0.3	100	0.03	0.03	0.2	20
carrots, raw (½ carrot)	25	10	trace	trace	2	10	0.2	2,750	0.02	0.02	0.2	2
lettuce leaves (2 lg)	50	10	1	trace	2	34	0.7	950	0.03	0.04	0.2	9
Fruits and fruit products												
Cantaloupe (½ med)	385	60	1	trace	14	25	0.8	6,540	0.08	0.06	1.2	63
Citrus and strawberries; orange (1), grapefruit (½), juice (½ c), strawberries (½ c), lemon (1), tangerine (1)		50	1	-	13	25	0.4	165	0.08	0.03	0.3	55
Yellow, fresh; apricots (3), peach (2 med), canned fruit and juice (½ c), or dried, cooked, unsweetened; apricot, peaches (½ c)		85	-	-	22	10	1.1	1,005	0.01	0.05	1.0	5
Other, dried; dates, pitted (4), figs (2), raisins (½ c)	40	120	1	-	31	35	1.4	20	0.04	0.04	0.5	-
Other, fresh; apple (1), banana (1), figs (3), pear (1)		80	-	-	21	15	0.5	140	0.04	0.03	0.2	6
Fruit pie; to 1 serving fruit add 1 tbsp. flour, 2 tbsp sugar, 1 tbsp fat												
Grain products												
Enriched and whole grain; bread (1 sl. 23 gm), biscuit (½), cooked cereals (½ c), prepared cereals (1 oz), Graham crackers (2 lg), macaroni, noodles, spaghetti (½ c, cooked), pancake (1, 27 gm), roll (½), waffle (½, 38 gm)		65	2	1	16	20	0.6	10	0.09	0.05	0.7	-
Unenriched bread (1 sl, 23 gm), cooked cereal (½ c), macaroni, noodles, spaghetti (½ c), popcorn (½ c), pretzel sticks, small (15), roll (½)		65	2	1	16	10	0.3	5	0.02	0.02	0.3	-
Desserts												
Cake, plain (1 pc), doughnut (1). For iced cake or doughnut add value for sugar. For chocolate cake add chocolate (30 gm)	45	145	2	5	24	30	0.4	65	0.02	0.05	0.2	-

(continued)

Food and Approximate Measure	Weight gm	Food Energy Cal.	Protein gm	Fat gm	Carbohydrate gm	Calcium mg	Iron, mg	Vitamin A Value IU	Thiamine mg	Riboflavin mg	Niacin mg	Ascorbic Acid mg
Cookies, plain (1)	25	120	1	5	18	10	0.2	20	0.01	0.01	0.1	-
Pie crust, single crust (1/7 shell)	20	95	1	6	8	3	0.3	0	0.04	0.03	0.3	-
Flour, white, enriched (1 tbsp)	7	25	1	trace	5	1	0.2	0	0.01	0.02	0.2	0
Fats and Oils												
Butter, margarine (1 pat, ½ tbsp)	7	50	trace	6	trace	1	0	230	---	---	--	-
Fats and oils, cooking (1 tbsp) French dressing (2 tbsp)	14	125	0	14	0	0	0	0	0	0	0	0
Salad dressing, mayonnaise type (1 tbsp)	15	80	trace	9	1	2	0.1	45	trace	trace	trace	0
Sugars, sweets												
Candy, plain, (½ oz), jam and jelly (1 tbsp), syrup (1 tbsp), gelatin dessert, plain (½ c), beverages, carbonated (1 c)		60	0	0	14	3	0.1	trace	trace	trace	trace	trace
Chocolate fudge (1 oz), chocolate syrup (3 tbsp)		125	1	2	30	15	0.6	10	trace	0.02	0.1	trace
Molasses (1 tbsp), caramel (1/3 oz)		40	trace	trace	8	20	0.3	trace	trace	trace	trace	trace
Sugar (1 tbsp)	12	45	0	0	12	0	trace	0	0	0	0	0
Miscellaneous												
Chocolate, bitter (1 oz)	30	145	3	15	8	20	1.9	20	0.01	0.07	0.4	0
Sherbet (½ c)	96	130	1	1	30	15	trace	55	0.01	0.03	trace	2
Soups: bean, pea (green) (1 c)		150	7	4	22	50	1.6	495	0.09	0.06	1.0	4
noodle, beef, chicken (1 c)		65	4	2	7	10	0.7	50	0.03	0.04	0.9	trace
clam chowder, minestrone, tomato, vegetable (1 c)		90	3	2	14	25	0.9	1,880	0.05	0.04	1.1	3

The use of the short method of dietary analysis reduces the time required to compute the nutritive value of a diet. In the evaluation of a mixed dietary using this method the accuracy approximates that of computations using the conventional food table. The values in this table were computed chiefly from the figures compiled by Watt and Merrill in Agriculture Handbook 8, Composition of Foods - Raw, Processed, Prepared, revised 1963. Courtesy of Leichsenring and Wilson, Journal of the American Dietetic Association, 27:386, 1951, Revised.

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Some Abbreviations Used in the Nutrition in Primary Care Series

ATP	adenosine triphosphate
c	cup
cc	cubic centimeter
CNS	central nervous system
FDA	Food and Drug Administration
gm	gram
IBW	ideal body weight
IU	International Units
kcal	kilocalorie
kg	kilogram
lb	pound
lg	large
MCV	mean corpuscular volume
MDR	minimum daily requirement
med	medium
μg	microgram
mEq	milliequivalent
mg	milligram
MJ	megajoule
ml	milliliter
oz	ounce
RDA	Recommended Dietary Allowances
RE	retinol equivalents
sl	slice
sm	small
Tbsp	Tablespoon
TPN	total parenteral nutrition
tsp	teaspoon
USDA	United States Department of Agriculture